Part 2

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

December, 1917

INDEX TO VOLUME 39

JANUARY - DECEMBER, 1917

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-ninth Street, New York

In Two Parts—Part One

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ACCOUNT OF THE ANNUAL MEETING

· JANUARY · 1917 ·

Volume 39 Number 1

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

JANUARY, 1917

	Page
The Annual Meeting	
Outline of the Meeting	1
Education in Engineering, Presidential Address, 1916, Dr. D. S. Jacobus	3
Tribute to John E. Sweet at Annual Meeting	8
Miscellaneous Session, Wednesday Morning	11
Surface Condensers, Testing House-Heating Boilers, Water for Steam Boilers.	
Industrial Safety Session	15
Code of Safety Standards for Cranes.	
Miscellaneous Session, Wednesday Afternoon	16
Waste-Heat Utilization, Power-Plant Graphics, Power-Plant Efficiency, Impact Tube, Air and Steam Flow.	
Textile Session	20
Heat Transmission through Sash, Spontaneous-Ignition Study, Vibration in Mill Buildings.	
Topical Discussion on Management	24
Machine Shop Session	28
Machine-Tool Standardization, Plan of Activities of Machine-Shop Committee.	
First Valuation Session	30
Accurate Appraisals, Industrial vs. Public Utility Valuation, Perpetual-Inventory vs. Appraisal Value.	
Second Valuation Session	35
Valuation of Properties vs. Methods, Productive Capacity as Measure of Value.	
Gas Power Session	40
Bituminous Producer, Producer-Gas Sampling and Analysis, Natural-Gas Characteristics, Internal-Combustion Engine Applied to Tractors, Werkspoor Diesel Engine.	
Miscellaneous Session, Friday Morning	43
Our Fleet and Naval Stations, Heat Treatment of Cable.	
Steam Boiler Session	44
Marine Safety Valves, Talbot Boiler, Downflow Boiler.	
Railroad Session	47
Clasp Brakes, Pulverized Fuel for Locomotives, Electric Locomotives.	
Work of the Boiler Code Committee	51
Society Affairs	
Secretary's Letter	53
Annual Business Meeting	54
Abstract of Council Report	54
Ira N. Hollis	56
Council Notes	58
Public Hearings by Boiler Code Committee	58
Symposium and Annual Reunion	59
Smoker at Annual Meeting	59
College Reunions	60
Annual Meeting Excursions	60
Candidates for Membership	62
Necrology	64
Among the Sections	65
Section Meetings	66
Student Branches	69
Employment Bulletin	71
Presentation of the John Fritz Medal	74
Past-Presidents Visiting China	75
American Uniform Boiler Code Congress	76
Sixty-Ninth Meeting A.A.A.S.	76
Engineering Survey	
Review of Current Periodicals	77
Selected Titles of Engineering Articles	94
Miscellaneous	
Library Notes	97
Dr. Douglas's Gift, Am. Soc. M. E. Accessions, U. E. S. Accessions	
Personals	99
Professional and Educational Directory	
Consulting Engineers	2
Engineering Colleges	4
Advertising Section	
Display Advertisements	8
Classified List of Mechanical Equipment	80
Alphabetical List of Advertisers	98

PUBLISHED MONTHLY BY

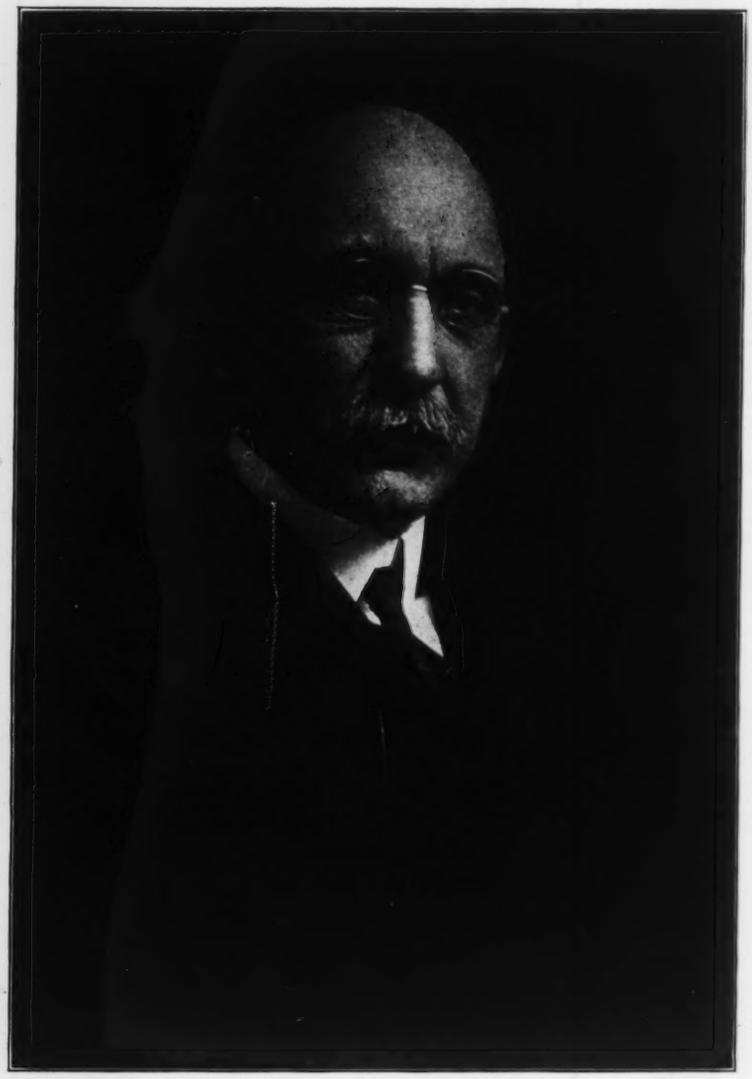
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-ninth Street, New York

Price 35 Cents a Copy, $3.00 a Year; to Members and Affiliates, 25 Cents a Copy, $2.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional.

C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Entered as second-class matter, January 4, 1912, at the Postoffice, New York, N. Y., under the act of March 3, 1879.



IRA NELSON HOLLIS

PRESIDENT 1917

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 39 January 1917 Number 1

THE ANNUAL MEETING

THE thirty-seventh Annual Meeting of The American Society of Mechanical Engineers, held in the Engineering Societies Building, New York, December 5 to 8, 1916, was the successful culmination of a year conspicuous in the annals of the Society because of the remarkable growth and the broad development of the varied activities of the organization during that period.

Outstanding features of the meeting were the record attendance, the unusually complete program arranged by the Committee on Meetings, and the spirit of coöperation which pervaded the whole proceedings and which rendered this meeting the most democratic which the Society has held.

The total registration was 1868, of which 953 were members and 915 were guests; the registration of members represented one in every eight in the entire membership. The total registration exceeded that of last year by 431 and showed an attendance from all sections of the United States.

This year, for the first time, as a result of the alterations and improvements in the Engineering Societies Building, it was possible to hold all the professional and social events of the meeting in the building. The social functions were simple in their nature, there was no charge for any of them, and the attendance was correspondingly large and representative. This situation served more than anything else to offset the usual conditions at big conventions that those who attend do not have a chance to get well acquainted. This feature of acquaintanceship, the encouragement of which has been one of the main purposes of the Annual Meetings, has now been developed to a degree which makes attendance at these gatherings immeasurably worth while.

As expressed by E. J. Prindle, Chairman of the Entertainment Committee, in presiding at the smoker on Wednesday evening of the Annual Meeting, everyone was requested to "consider that the fellow on your right hand is modest and would like to know you; and that the fellow on your left hand is interesting and well worth talking to." This sentiment admirably voices the evident feelings of those who came to the convention and is one to which all apparently responded in the most cordial manner.

> *"We have a duty clearly laid before us by William James when he writes, 'The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state.'*
>
> *"That is our motto and that is what we must strive toward during the coming year and for all time, as we must pass on into the higher atmosphere of goodwill, service and co-operation in order that our profession may take its place alongside of the science of Preventive Medicine, as one of the two constructive agencies in human life. It will not be enough that we remain simply conscious of the high mission of our profession. We must serve as soldiers of peace in a country prepared to defend its homes."*
>
> *IRA N. HOLLIS, in accepting the Presidency of The American Society of Mechanical Engineers.*

As at recent meetings, there were delegates from most of the local Sections, sixteen of the twenty being represented at this meeting. Several conferences of these delegates were held, which were productive of numerous suggestions that will be helpful to the Sections and to the Society generally. More and more, the influence of the local Sections is being felt. They already play a major part in the conduct of the Society. They are representative of the Society's membership, covering as they do the whole expanse of the country. They include all shades of opinion. Because of these strong local affiliations they are influential factors in their communities, and are developing coöperation in the engineering profession.

A wealth of experience was contributed at the twelve professional sessions held during the meeting, at which 36 papers were presented. Several of these sessions were in charge of committees or sub-committees and five of the papers were contributed by local Sections, having previously been read at Section meetings and because of their exceptional value assigned also to the Annual Meeting. Two committee reports were considered and the public hearings of the Boiler Code Committee continued the professional meetings until Saturday.

PRESIDENTIAL ADDRESS AND RECEPTION

The meeting was opened on Tuesday evening, December 5, in the auditorium of the Engineering Societies Building with the presidential address by Dr. D. S. Jacobus, on Education in Engineering. In his presentation of this subject, Dr. Jacobus analyzed, in the light of his twenty years' experience as a teacher of engineering subjects and his ten years' acquaintanceship with the practical side of the engineering profession, the fundamental requirements in education of an engineer and reviewed his own suggestions for attaining the best results. The full text of the address follows this brief introductory account of the convention.

After the address, the Tellers of Election of Officers reported the result of the balloting as follows:

Total Votes Cast	2261
Thrown out defective ballots	1
Valid ballots counted	2260
For President:	
IRA N. HOLLIS	2259
Scattering	1
For Vice-Presidents:	
CHARLES H. BENJAMIN	2253
ARTHUR M. GREENE, JR	2253
CHARLES T. PLUNKETT	2255
Scattering	7
For Managers:	
ROBERT H. FERNALD	2256
WILLIAM B. GREGORY	2256
C. R. WEYMOUTH	2255
Scattering	1
For Treasurer:	
WILLIAM H. WILEY	2260

The newly-elected President, Dr. Ira N. Hollis, President of Worcester Polytechnic Institute, was escorted to the platform and in accepting his election spoke as follows:

"MR. PRESIDENT, I thank the Society for having elected me president to serve during the coming year. Entirely apart from the high honor which you have conferred upon me, I accept the office as a serious duty and as a great opportunity for service. That word alone expresses what should be the motive behind the actions of every citizen of our Republic and especially of every engineer who is charged with tasks involving the safety and well-being of his countrymen.

"This is not the occasion for a long address from me, but I cannot refrain from just a few words on what I conceive to be the fundamental relation of our profession to society. We have for years worked honestly as individuals who long for the success, comfort and beauty of every American city. Now, we are at the dawn of a consciousness of our place and our duty as an association in which every member is eager to coöperate with every other members to the greater glory of our country.

"There are two thoughts that lie in the subconsciousness of every engineer. They are brought out in one sentence of 'The World Set Free' by H. G. Wells, and in the whole tenor of an essay by William James on the 'Moral Equivalent of War.' In the first sentence of Mr. Wells' book, he expresses the underlying force that has made man a civilized, reasonable being. 'The history of mankind is the history of the attainment to external power'; that is, to the use of energy external to man's body. Somewhere behind every great human problem lies the work of the engineer. Our country is a perfect example of this in its evolution from a few colonies with imperfect means of communication into the United States of America. A history of the great inventions and the changes wrought by the applications of science will some day reveal the potent influence of our profession upon every department of national life. What made the great slaveholding states possible? The Cotton Gin. What, therefore, created the whole atmosphere of political discussion during sixty years of the nineteenth century and finally plunged us into a great war? The Cotton Gin. What again saved the Union and welded it into one country from coast to coast? The railroads. We can name few of the questions before Congress that do not in origin or in their solution depend in some way upon the engineer. That is the complete justification of Mr. Wells' statement and of our existence as a society of engineers.

"We have a duty clearly laid before us by William James when he writes, 'The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state.' That is our motto and that is what we must strive toward during the coming year and for all time, as we must pass on into the higher atmosphere of goodwill, service and coöperation in order that our profession may take its place alongside of the science of Preventive Medicine, as one of the two constructive agencies in human life. It will not be enough that we remain simply conscious of the high mission of our profession. We must serve as soldiers of peace in a country prepared to defend its homes."

The remarks of Dr. Hollis indicate that the efforts of the Society for the coming year will be in the direction of public service; or, as he expressed it, that the motto will be "service to the state."

The President's Reception, which followed the exercises in the auditorium, was held this year on the remodeled and spacious fifth floor of the building, the large halls of which are now connected by three doorways 12 ft. wide. The brilliantly illuminated rooms were most attractive with their decorations.

OUTLINE OF MEETING

As usual, the business meeting and first professional sessions occurred on Wednesday morning. At exactly 12.30 o'clock, the sessions were brought to a close in order to honor the memory of John E. Sweet, the beloved founder of the Society, whose keen personality and simplicity of manner will long endure in the minds of all who knew him. A most fitting address was made by one of his older friends, Past-President Worcester R. Warner, and brief remarks were also made by Capt. Robert W. Hunt and by Dean Albert W. Smith, of Sibley College. Mr. John H. Barr, one of "Sweet's Boys," presided.

On Wednesday afternoon no less than four varied sessions were held simultaneously. On Thursday, attention was concentrated on the subject of Industrial Valuation for which an all-day meeting had been arranged. No other sessions than this were held in the morning, but in the afternoon there was a well-attended meeting in charge of the Gas Power Sub-Committee.

Friday ended the professional sessions with meetings in charge of the Railroad Sub-Committee and the Boiler Code Committee, besides one Miscellaneous Session at which a remarkably strong paper was given by W. L. Cathcart on the Development of our Fleet and Naval Stations.

In the afternoon of Friday, the public hearing of the Boiler Code Committee began, which continued on Saturday. The work of this Committee is increasing in importance and effectiveness and its accomplishments bid fair to be among the most enduring works of the Society.

On Friday evening, many of the college men who had been in attendance, attended banquets of their own institutions and joined in what has become an annual event for the alumni of several of the colleges or universities which have engineering courses.

The success of this, the largest and in many respects the best Annual Meeting which the Society has ever held, is due to the untiring efforts of the many committees actually engaged in its conduct. The convention as a whole was in charge of the Committee on Meetings, H. L. Gantt, chairman; and the entertainment in charge of the New York Section Committee, H. R. Cobleigh, chairman, with E. J. Prindle as chairman of the sub-committee on entertainment. The President's Reception was under the direction of the House Committee, William N. Dickinson, chairman. The welfare of the ladies was carefully provided for by the Ladies' Committee, Mrs. Herbert Gray Torrey, chairman.

ENTERTAINMENT FEATURES

Many of the New York members willingly assisted in the reception of out-of-town members and in making everyone acquainted through the organization of the President's Reception and Acquaintanceship Committees. The excursions were planned by a committee for that purpose, J. H. Norris, chairman.

The plan, instituted last year, of a Smoker on Wednesday evening of the convention was again followed with unqualified success. Like most of the other social affairs, it was held on the fifth floor and it was attended by about 750 who enjoyed the evening to the fullest extent. In a talk upon his experiences during a trip to Europe since the beginning of hostilities, Frank B. Gilbreth had his audience with him from beginning to end and withal made comments upon the situation which deserved serious thought.

On Thursday evening, the members and their friends assembled in the auditorium to listen to the symposium which had been arranged by the New York Section Committee on the subject of Aviation. There were four prominent speakers. Following the lecture those who desired went to the fifth floor to participate in the dancing and refreshments were served there as well as on the eleventh floor in the Society's rooms. The whole affair, while in a marked contrast to the more elaborate functions which have heretofore been held at the Hotel Astor or elsewhere, was pleasing to all who attended because of its simplicity and the fact that the chief reason for attending was the opportunity which it gave to meet other friends of the Society, and their friends.

Excursions were arranged for Wednesday, Thursday and Friday to several points of interest in New York and vicinity, and the plan, followed last year so successfully, of having comparatively few excursions, but trips of unusual interest, was again adopted. There were eight excursions, an account of which appears in the Society Affairs section of this number. Several of these were of interest to the ladies as well as to the men.

Not the least pleasing of the social occasions of the meeting was the tea served by the New York ladies in the Society's rooms on Wednesday afternoon, where at the close of the professional sessions many members were received.

PUBLICATION OF PAPERS

Most of the papers presented at the Annual Meeting have already appeared in the November and December issues of The Journal. In this issue will be found a comprehensive account of the discussion given at the various sessions and in the Society Affairs Section a further account of the entertainment features, excursions, etc. Papers which have not already appeared in The Journal will be published in comprehensive abstract form in early issues.

EDUCATION IN ENGINEERING

Presidential Address, 1916

By DR. D. S. JACOBUS

So much has been said and written of late about education that it might seem too worn a topic to bring before our Society, but having been a teacher of engineering subjects for over twenty years, and having for over ten years since that time been employed in what some are pleased to call the practical side of the engineering profession as distinguished from the teaching side, I feel qualified to pass judgment on certain features and trust you will bear with me if what I say seems more or less elementary.

Let us start with the professor—and let me say here that once a professor always a professor, provided one has felt the joy that goes with being in close touch with his students and in knowing that there is a mutual understanding and trust. Some are apt to class the professor as an impractical individual whose principal joy in life is to dream and idle away the long summer vacations, while others give him what is more nearly his just due. Let us look back on our own professors, those who taught us, and see what led to our respect and what qualities we would now regard as the most important. I feel sure most of us would not depart very far from the judgment of those who responded respecting the list which was prepared by the Carnegie Foundation for the Advancement of Teaching as the essential factors desirable in young engineers. The order of importance based on the replies received is as follows:

1 Character, integrity, responsibility, resourcefulness, initiative.
2 Judgment, common sense, scientific attitude, perspective.
3 Efficiency, thoroughness, accuracy, industry.
4 Understanding of men, executive ability.
5 Knowledge of the fundamentals of engineering science.
6 Technique of practice and of business.

As we grow older we see that the personality of the men more than any other quality left its lasting stamp, and that

---

Presented at the Annual Meeting, December, 1916, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. Pamphlet copies may be obtained; price 10 cents to members, 20 cents to non-members.

it is this more than anything else that causes us to look back with kindness and affection to our college days. Character is the first on the Carnegie list, and this as well as many other qualities that are to an extent independent of the course of study precede those that relate to the technical side of the course. In the discussion of engineering education the details of the courses are apt to be given undue weight, which is a grave mistake. System can never take the place of personality, and a given course that would be a success when taught by the right men might be a failure if taught by others.

Let us analyze the factors in the Carnegie list. First of all it is apparent that most of them apply to any profession and that they are not limited to engineering. Again, it might appear that one should succeed in a profession if he possesses the first factors in the list, even though he may not possess those included in the last two items. It would be a dangerous conclusion for a young man to feel that his success is assured if he has character and the other qualities which come near the head of the list, and that it is not necessary for him to have thorough knowledge of the technique of his profession. Such an unfortunate would soon find that the ethical qualities alone will not earn his bread and butter, and that a lack of knowledge in his profession will be an immense handicap.

What are the particular elements that spell success for a young engineer in addition to the elements that are common to all professions? Dear Uncle John Fritz once said that he could tell whether a young lad would be apt to succeed by watching him unobserved when sweeping a sidewalk. Yes! and we will all agree that much depends on what is in the lad. Eckley B. Coxe talked with me earnestly in the good old days as to what he considered the failure of some colleges to secure the right timber in their graduates. He compared the ordinary system of examinations to riddling the men through a series of sieves and throwing out the unfortunate fellow who had peculiarities that made it impossible for him to pass through the mathematical or other sieve. Mr. Coxe was a firm believer that there is a "something" required in the making of an engineer which cannot be gaged by an ordinary examination, and I remember well that he told me he employed some highly paid men who did not know an integral sign from a dollar mark, and that he knew of others classed as the best of graduates he would rather pay high salaries to keep out of, than in, his organization. What is the "something?" What is it that the old-time superintendent has in mind as he shakes his head sadly when asked how some young graduate is progressing. The lad may have character, judgment, and perhaps everything in the Carnegie list, or at least he may think he has, and yet our old-time friend, often from the land of the heather, knows there is something lacking. And we ask again, what is this "something"?

Would that I could define the "something." It includes such qualities as:

Taking a personal interest in one's work
Amenability to discipline
Perseverance under adverse circumstances
Cheerfulness and amity—the human side.

None of these appear separately in the Carnegie list.

Let us analyze these qualities. It will be seen that possibly a lad from a grammar school would be as likely to possess them as the college man. If this is so, then there is a lack in this side of the college training, and it is here that we should improve. Consider the first: "Taking an interest in one's work." In this the college man often fails. I have known of cases where on being censured for lack of accuracy the college man said that he could not take enough interest in the work as it was not up to his capabilities and could be done by any office boy; and often a bright office boy would pass him. The young man to succeed must take such an interest in his work that he will take pride in doing it in the very best way, be it what it may. He should be determined to hang on until the finish. The man who has an engagement that calls him away when he is asked to help in an emergency, seldom wins. The practical foreman will often keep the young college man he is trying out on monotonous work to determine his staying powers. Industry is given as an essential in the Carnegie list, but the determination and staying powers that count for success include more than simple industry. The man must be more than industrious; he must not only work hard and continuously, but be so interested in his work that he feels a personal responsibility in it. Further, the "industry" should be of the sort that is not governed by the clock, but which calls for many nights of labor, either in home study or in the field. Success is the fruit of hard labor achieved through the building up of many things into a grand and harmonious whole. The Good Book speaks of time-servers and those who work from the heart; there is no better criterion to distinguish between one who will fail and one who should succeed.

The second is "amenability to discipline." There is a lesser importance assigned to this than there should be in other as well as in teaching lines. The old-time preceptor with his hickory rod or stout ruler was but carrying out the home discipline where the word *obey* carried its full force. Perhaps the wave will change to bring back the good features of the old *régime*,—let us hope so. We certainly can and are doing much in our colleges to teach respect for authority and obedience to rules, but we should do more; let us not overlook this most important part of an engineer's equipment, and emphasize the importance of his being governed by these principles in the field.

The third is "perseverance under adverse circumstances," and the fourth, "cheerfulness and amity." The most unfortunate frame of mind a young engineer can get into is to feel that everyone is against him and that his efforts are not appreciated. I have often told the young men that those who select them take a pride in seeing them succeed. Believing a thing is so may often make it so, therefore the young man should encourage cheerful beliefs. To succeed, one should make friends of those about him. There is no surer way of making a man an enemy than to mistrust him. Great things can as a rule be done only through coöperation, and in the broad analysis the human side has much to do with success. "Study your man as well as the job" is a good motto to follow, but with it should be coupled a perseverance and cheerfulness that will induce the man to study you.

In applying for a position the young graduate will often injure his cause by inquiring too minutely respecting the prospect of advancement. Again, after being employed he may have the idea that in view of his special training his work should be in line with developing this training and that he should be given a certain preference over an untrained man. Such an attitude is bound to lead to discontent and misunderstanding. I have advised graduates many times to "size up" their chances before applying for positions and not to talk prospects, and have further impressed on them that they must enter the outside world on an even basis with their co-workers, and that any advantages they secure through education must come through the ability this education gives them to do better work than the others.

Having thus briefly reviewed the qualities necessary in an

engineer, let us consider the student. How can we bring out those qualities which we all agree are the most important. Character can best be taught by example, and the teacher must serve as an inspiration and guide. To teach effectively one must be a master of his subject, and this applies particularly to those qualities placed near the head of the Carnegie list.

We hear and read much respecting teaching methods. Methods are not all; the spirit which unconsciously develops is a most vital factor. I cannot fail to observe that there has been a great change in one respect since I was a boy. In my school days a failure to acquire a subject was laid to the student; now there is a tendency to lay it to the teacher. Much of this is due to the attitude of the parents. A fond mother once told me she thought it strange that no teacher could be found capable of teaching her boy mathematics, not realizing that she herself might be the greatest stumbling block through transmitting the idea that the fault lay anywhere else than with her son. A way never has and never will be found to acquire knowledge without study, and much of the trouble experienced by some students arises through a lack of study or a failure to appreciate the fact that the fault is their own.

Where the teacher is often at fault is in his failure to train the lad to study in a proper way. To memorize is the lowest form of study, and much of our present system may be justly criticised in this respect. A certain amount of memorizing is essential to "train the mind," as those who taught us used to say, but there is much in the doctrine expressed by that lovable professor, John E. Sweet, in the words, "What is the use of teaching a man a mass of material he is bound to forget?" We should develop initiative and encourage originality, and this cannot be done through memorizing or through any fixed course. It is here that a teacher who is worthy of his calling excels one who takes the easiest way. There is an easiest way in teaching just as there is an easiest way in studying, and both spell lost time and lost opportunities. The easiest way in teaching is to follow a beaten course and rely on the recitations and routine examinations in grading the men. To preserve the standard it is appreciated that the weaker men should be weeded out, and by so regulating the course that the weaker men fall by the wayside it might appear that the brighter men will remain and that there will be a "survival of the fittest." Such a course is fraught with the gravest dangers, as some of the best men may be dropped or may leave through being discouraged, and the college, though it may do good to many, may also do untold harm. Again, those who remain and graduate may have highly trained memories with little initiative and power of reasoning. The right way is for the professor to know the individual characteristics of each of his students and to be governed by this in deciding a case. Often if he can get at the root of a special difficulty it can be cleared away and there will be no further trouble. Still, there are cases where the student does not have an aptitude or liking for engineering, and in such instances it is a kindness to start him in some other line of work.

To accomplish the best results the course should be so laid out that there will be the right amount of time for rest and recreation. The student should be encouraged to spend a proper amount of time in outdoor exercise. A healthy and clean body is indispensable for a healthy mind and is even more to be desired than a trained mind. Just as soon as a course becomes so crowded that there is no time for anything but work and study, it will lose in efficiency, as there will then be no time for daily relaxation of the mind and for properly developing initiative. To obtain the best results the student must work enthusiastically and cheerfully, and if the course is such that he is constantly on the anxious seat, his perspective will become shortened and he will work at a disadvantage. We should train the student to work in the same way that he should work after his graduation. It is often remarked that students working their way through college stand surprisingly well, considering the amount of time available for study. We all agree that the man who does this has determination that makes him bound to succeed, but it is this determination that leads to a proper method of study and the clearing of his mind through thinking at times of entirely different subjects than his studies that makes his brain keen and quick. The students should be encouraged to occupy their spare time in some congenial way; there is nothing better than a good, healthy fad. But, it is asked, how shall we know that the spare time is used to advantage, and would it not be best to completely fill every hour of the day and thus, as some have said, keep the boy out of mischief? It is here that the human side of the professor must be brought into play, and to properly apply this side he must know his pupil and know him well. The classes must not be so large that it is impossible to obtain the intimate personal relation which is indispensable.

Recitations and examinations should be so conducted as to bring out more than can be memorized and to take into account the widely varying factors of temperament. It is far easier to lead and have the students follow than to call for initiative and guide them back if they depart from the right path, but the easiest way results mainly in training the memory, whereas the other includes the developing of qualities that are most apt to lead to success.

To teach engineering efficiently the professor should have practical experience. Sometimes this is acquired before the professor begins his career as a teacher; in most cases, however, the professor undertakes practical work in connection with his college duties. To secure the best results where the professor undertakes practical engineering work, the roster should be so arranged that certain of the professors dealing with the more practical engineering lines are given latitude in meeting the classes. One must not be misled into the idea that if a certain latitude is provided it will be an easy matter for the professor to undertake this work. He will find that to accomplish results he must often work night after night, as well as through the vacation periods, and unless he is willing to do this it is folly for him to endeavor to gain practical experience and a reputation in this way.

There is no enterprise that will reflect more credit on a college than undertaking properly conducted experimental investigations, especially if those suitable for the purpose are made the basis of papers presented to engineering societies or published in the technical press. The making of experiments and the issuance of reports carry with them grave dangers, in that there may be a tendency to do work for which the professor has not the proper capacity, and reports may be made that will throw discredit on his college. A professor should not be permitted to endorse commodities where the idea is simply to obtain his name, or worse than this, his name in connection with his college, for use in advertising matter; nor should he allow his name to be used in tests which may be of more value to the promoter than to the engineering profession. Above all, he must be careful in his reports and in his testimony as an expert not to bring discredit to his profession and his college by departing a hair's-breadth from the truth or by testifying in a way which will evade the truth. There is danger in any enterprise where responsibility is assumed, and here as in all other such enterprises success or failure is dependent

on the organization and character of the men. A great advantage, aside from efficiency in teaching, of having professors in close touch with the outside world, is that such professors can place many of the graduates in positions for which they are especially fitted. This naturally can only be done where the professor, in addition to having a large acquaintance in the practical field, also comes into intimate contact with the students so as to know their individual peculiarities and characteristics.

Let us now consider the broad aspect of education. "We live to learn" applies most truly to the engineering profession. We must continue to study and learn as long as we hope to be active and advance in our profession. Just as soon as one reaches a point where he does not appreciate the value of other people's views, just so soon will he come to a standstill. It has been truly said that a big man will take most kindly to suggestions and that only the little man will resent them. We learn from day to day and soon appreciate the fact that time spent at school is but the beginning of a lifelong course. How does the school course assist us, and what should it include to be of most use? How long a course should it be, and should we send our sons to college? In the replies respecting the Carnegie qualifications, knowledge of the fundamentals of engineering science and technique of practice and of business were placed at the end of the list. If the judgment of those who responded is correct, are we not taking too much valuable time for such training, and would it not be just as well to shorten the college course? It is an open question whether much could not be eliminated from the college course to advantage, provided special attention is given to teaching the fundamentals. Once thoroughly mastered, the student will always carry with him the fundamentals of physics and mechanics, whereas much that relates to special applications will soon be forgotten. Again, the college should graduate its men young enough to preserve the adaptability of mind which the younger man possesses to a far greater degree than an older. If the assumption is made that the fundamentals are thoroughly mastered and the student graduated a year in advance of what he would be should he study along a number of specialized lines, most of those who employ graduates would favor the younger man with a keen knowledge of the fundamentals to the older man with what might be a lesser knowledge of the fundamentals and more knowledge of specialized lines. The question of whether the school course should be shortened depends on how it is shortened. Shortening the time spent in college may not shorten the course of study as a whole.

As far as can be determined from statistics, the average age of graduation from college has not changed appreciably during the past century, being somewhat over twenty-one and a half years. It would therefore seem that, irrespective of what is taught, there are elements entering a college course which have led to men graduating at about this age. I believe it advisable to have a four-year college course, but I would make the entrance requirements and the course such that the students would be graduated at as early an age as has been and is the current practice.

I have taken the stand and firmly believe that our present entrance requirements do not accurately gage the ability of an applicant, and that it is a mistake to make the entrance requirements too high for an engineering college. High technical requirements may result in the preparatory schools specializing along narrow lines in an endeavor to have the student enter college at an early age, to the sacrifice of a broader education. Again, high technical requirements discourage those who have worked in machine shops and the like and later on desire to enter a college. I have watched and encouraged such men and appreciate how hard it is for them to bring their minds back to the different studies; still, once these men get the right hold, they make the best of students and later the best of engineers. Where I have expressed this view the question has been asked, "How can we select men for the colleges if we do not rely on examinations, and how can we secure as good men with lower requirements as with higher requirements?" My reply has been that, in addition to the examinations, each and every applicant should be met by a board, and all of the circumstances connected with his case considered. Further, the examinations should be given in a way that will bring out the reasoning powers of the students, which can be accomplished if each man is given an oral examination of some length. Here again we have the harder against the easier way, but I am firmly of the opinion that there is no easy way of doing good teaching.

There can be no doubt that for many classes of engineering work much in the average college course is not needed. In certain instances we might well give over some of the time spent in specializing to teaching the fundamentals, with enough application to secure a thorough drill and to give the students confidence in their ability to solve practical problems. Fundamentals can be thoroughly mastered only through application. Further, it has been my experience that in training the average mind the fundamentals must be approached from different viewpoints, and that there is a great advantage in several teachers presenting subjects requiring the fundamentals to be applied in various ways. A student may memorize all definitions and be able to solve certain problems in a routine way, but on viewing a principle from another angle from the one to which he is accustomed he may be completely at sea.

The aim in teaching should be to produce a man who will be the most useful to his fellow-men and to his country. Just as we give, so we receive. The fruit of usefulness is achievement, and the building up of achievement, success. We should above all consider the human side and aim to produce a broad man with spirit and determination. It is my firm belief that in many cases we could produce graduates who would more nearly meet our ideals by cutting out much from the present courses of study and by teaching more thoroughly matter already in the courses. The course should be broad enough to include some of the so-called cultural studies, and it further should deal with the business side of the profession. Dr. Alexander C. Humphreys was the first to introduce a regular course of economics in an engineering college, the course including accounting, depreciation, shop cost, law of contracts, specifications, appraisals and business methods in general. As an illustration of matter already in the course that it would be well to teach more thoroughly, I can refer to the writing of concise and logical reports in good English. To this might be added speaking on one's feet before a meeting.

To really know a thing one must have more than an abstract knowledge. Much can be gained by having the students make or witness experiments which verify or illustrate the principles. What a student does with his hands in connection with his head he remembers far better than knowledge which he has obtained from text-books or lectures. The courses in departments having laboratories should be so arranged that work in the laboratories is given in parallel with the work in the class room. There must be close coöperation between the departments, with this end in view. It was a part of my pleasant duty when teaching to review the fundamentals after they had been taught by others. Good results came through the use of

apparatus to illustrate the principles and in giving the students practice in the solution of many problems in which the principles had to be viewed from different standpoints. That the apparatus helped was evidenced many times by the students sketching out the principles as applied to the experiments before they applied them to a problem, which showed that they carried the principles through a visual recollection of the experiments. Again, the principles were applied over and over again in laboratory experiments. To thoroughly master principles the hand, sight, and mind must be brought into intimate harmony and brought into harmony many times, and unless this is done the student will not have an understanding that will make the principles dependable working tools.

Instructions for laboratory practice are often so complete that the students are led to such an extent that there is a failure to call for the proper amount of initiative. This may or may not be so with a given set of instructions, all depending on the way in which the teacher presents the subject. He may often economize much time by using properly prepared notes, and he may train the initiative by inspiring the students to follow up the details and bearing of the experiments. Special exercises where the students are required to determine certain quantities without the use of any instructions, either oral or written, or with few instructions, form a most useful adjunct, but here again all depends on the way in which the subject is presented. Too much should not be done in setting up laboratory apparatus for the students. The men should be encouraged to ask questions; where questions are not asked it is a sign that something is wrong with the method or the teacher.

Laboratory exercises form a useful basis for practice in writing reports. The best results are secured by returning all reports with carefully marked criticisms, and requiring the student to rewrite those that do not come up to the standard. It may often require two or three or even more rewritings to make a report readable, but if this method is followed up conscientiously it will result in vast improvement. Here again the method is not the easiest one. A lack of proper examination of reports soon results in a falling off in interest and in the effort of the student. There is nothing more discouraging to a student than to have his work carelessly examined, and in good teaching much time must be spent on this part of the work.

As to education in general, we all agree that our sons should be trained along well-balanced courses. The shop foreman who received only a grammar-school education will send his son to college, for he knows what it means to be handicapped through lack of training, and how hard it is to make up for that lack of training by studying at nights later in life after long working days; as study he must to keep in the race with the college-trained man. In many instances where I have worked long enough with the men at a plant to really know them, it has been touching to find how many, especially the older ones, appreciate the fact that they have lost their opportunities. Many a time such men have come to me and said that I should make it my duty to warn young men to get an education. Yet many of these men had all the qualifications in the Carnegie list except the two items which those discussing the list have classed as the least important. One does not have to turn to the successful man to find character; many a man who has missed his chance has noble qualities and is a prince at heart. We should not therefore belittle these two items, even though we agree on the importance of those that precede them, for their lack has led many a man to failure.

One of the greatest pleasures of the professor is to watch the progress of those he knew so well after they leave him. It is indeed interesting to see the boy in the man, for although his students may grow old, there are still the same traits and peculiarities. The professor has a grave responsibility in that he directs while the mind and character are in a plastic state and his imprint may mark the destiny of his charge. It has been truly said that training a boy is like growing a young tree: easy to direct if taken in time, but hard if neglected or if started in the wrong way. Again, boys develop like growing trees: some young, sturdy trees may outtop the others, some may be checked for lack of space for development and transplanting to some congenial spot may help. It would be a poor planter who would discard some thrifty, young tree that might not come up to all his ideas of symmetry. The good planter would so bend and train it that its development would overcome its faults.

Having outlined the general principles of engineering education, the question may be asked, how should we proceed to obtain the best results? I believe that much good would be accomplished if those who employ graduates would coöperate in laying out the courses of study. The visiting boards of some colleges are a step in the right direction, but we need something closer and more concrete than is secured through most such boards. The engineering societies could do most fitting and useful work if they would go seriously into the problem. What is needed is a careful consensus of the judgment of many. A single man or a small group of men might have radical ideas which might do much harm if enforced. Even though an idea may be essentially good, care should be taken that the pendulum is not swung too far one way or the other, or the course will be unbalanced. All of us who have taught know of the frequent requests made by engineers, usually graduates of the colleges, that instruction be given along particular lines which have been of importance to them, and that should even a fraction of such requests be complied with the course would soon be overcrowded, or if other matters were dropped would soon consist entirely of specialized branches. The demand for instruction along particular lines has resulted in the courses of technical colleges being crowded at the expense of efficiency, and no additions should be made unless these seem desirable after a thorough study of the course as a whole to make sure the added matter will not displace something more valuable or result in a lesser degree of thoroughness in some more important branch.

We often hear the statement that something should be added to teach common sense. If by this is meant adding something to keep the student awake to the fact that there is much more for him to do than memorize and that he should keep his mind alert to grasp and coördinate facts and essentials, the suggestion is a good and basic one. The idea that there is a lack of common sense in graduates of colleges is sometimes overcarried. Often the one making the statement has a mind so fixed that he regards a graduate who does not look on a thing in the exact way he does as lacking in capacity. He wrongly regards the failure to follow fixed methods in reasoning as a lack of what he considers his own good common sense. The very failure to follow fixed methods is a safeguard which has been cast about the young mind to insure advancement and progress. Were the world to follow along the lines laid out by our older friend with his highly prided but set ideas, we might soon be in a rut that would prevent all advancement, whereas the young man, though he may fail, may also win through starting out enthusiastically in new and unknown fields. Let us therefore forgive the young man if he makes mistakes in matters that seem self-evident, and remember that the very freedom of his mind is the greatest safeguard for continued progress.

Summarizing, I would make the following suggestions:

1 That there be a closer coöperation between the engineering colleges and those employing graduates, and that the engineering societies be encouraged to work along this line.

2 That the technical requirements for entrance to colleges be lowered rather than raised, that preparatory schools be encouraged to give more attention to teaching good English and fo giving a broad general education, and that applicants be also judged as to their initiative and general make-up in deciding whether they should be admitted.

3 That the courses be so arranged as to train the initiative and develop the human side; that the students be taught to work in a cheerful and efficient way; that there be proper time for daily relaxation of the mind and that the students be encouraged to use this time to the best advantage.

4 That the professors get down to hard work with their students and know all of them well enough to be thoroughly acquainted with their personal characteristics.

5 That the professors in practical engineering subjects have practical experience so that they can speak with authority.

6 That professors in charge of practical engineering departments be encouraged to undertake practical engineering work, and that their college work be so arranged that they can be relieved from meeting classes when the engineering work makes this necessary.

7 That special attention be given to teaching the fundamentals of engineering science, even though this may result in the elimination of certain specialized branches.

8 That greater practice be given in the writing of concise and logical reports in good English, and in speaking on one's feet.

9 That the students be encouraged to confer with the professors, and that regular hours be provided for this purpose, all to the end that the teachers may extend a helping hand where needed and that there be a mutual understanding and trust.

TRIBUTE TO JOHN E. SWEET AT ANNUAL MEETING

AS a tribute to the late Dr. John E. Sweet, Past-President, Honorary Member and a founder of the Society, who died on May 8, 1916, the regular business of the Annual Meeting was suspended at 12:30 p. m. on Wednesday, December 6, when a memorial service to Professor Sweet was held in the Auditorium of the Engineering Societies Building.

Prof. John H. Barr presided at the exercises, and the members of the Council and of the Council-elect, and the past-presidents of the Society took seats upon the platform. The Chairman announced that the ceremony would open with an address by Mr. Worcester R. Warner, Past-President of the Society, and Capt. R. W. Hunt escorted Mr. Warner to the platform. Mr. Warner paid the following tribute to the memory of Professor Sweet:

MR. WARNER'S TRIBUTE

In honoring the memory of Prof. John E. Sweet we stand at the shrine of one whom to know was to admire and love—of a personality instinct with qualities that live to bless the world endlessly, through perpetuation in the lives of others.

To all members of The American Society of Mechanical Engineers he was known as the revered founder and third president of this Society.

As long ago as 1880 I, myself, received a letter from him in which he outlined the scope and benefits of such an organization and invited me to become a charter member.

In those remote days the term Mechanical Engineer had a very limited application. It did not appear in college courses or degrees. There were some Master Mechanics and Master Builders and Draughtsmen; but to secure sufficient members as a nucleus for his proposed organization, Professor Sweet had to invade the ranks of Foremen and Machinists—and there, I may add, is where he found me and some others.

Recently he wrote: "Likely the most important thing I have done was to set the ball rolling for the organization of The American Society of Mechanical Engineers, of which there are between four and five thousand members scattered throughout the inhabited surface of the world." As he was proud of the founding, justly so may we be proud of the founder.

Professor Sweet left a brief and very characteristically modest outline of his life history from which it appears that he was born, of plain English parentage, in the village of Pompey, near Syracuse. His educational advantages were few but he and a brother developed marked taste and aptitude for mechanics. "I was always at making something," he says. Not unnaturally, therefore, he eventually learned the carpenter's trade, from which, as he says, his "mechanical life ran into architecture," and he adds that there are in Syracuse several buildings designed by him. Whimsically he explains that as "the Government at the seat of war at that time was giving jobs to those who wanted to stand up and be shot at, which was a job he 'didn't hanker for,'" so, in 1862, he went abroad and "visited London, Paris, Switzerland and Italy." For nearly two years thereafter he had employment in England. On his return to America he invented his very ingenious but commercially impracticable machine to supersede movable type—the forerunner of the linotype. Then he undertook bridge construction and tells how it was while he was building a bridge at Ithaca that "President White and Mr. Cornell came around one afternoon" and asked him "to meet the Cornell Board," from which resulted his appointment as Director of Shops in Sibley College. The six years, from 1873 to 1879, during which he taught there, were full to overflowing of activity in the interest of his "boys," between whom and himself existed those remarkable bonds of regard and affection expressed in their long series of annual gatherings with him in recent years. "At Cornell," he says, "we were constantly developing new things: absolutely perfect surface plates, straight-edges, squares and angles, standard gages — by the use of the measuring machine which we built (the first ever built in this country) and which read to the ten-thousandth of an inch and enabled us to judge the forty-thousandth. Visitors to the University were always shown our shop and the wonders of the work we were doing interested the greatest of them all. Mr. Cornell was a constant, interested visitor while he lived. General Grant, John Hay and hundreds of others came." "In conversation with Henry Ward Beecher," he adds, "I casually remarked that an ordinary college graduate was not much use in a machine shop and he said he guessed I had never seen one in a pulpit!" Another incident that diverted the young professor, he thus describes: "We built certain

lathes, and, among other new things, all the bolts and nuts that had to be changed to meet conditions were made to be operated by the one wrench. Showing it off to a friend, he said, 'What in the world would you do if you lost that wrench?'" With deep feeling he sums up that period thus: "The best thing we made or helped make at Sibley, I suppose—or hope at least—was a lot of valuable men." From these fine men, "Sweet's Boys," have proceeded such answering testimony to the worth of their instruction by this tireless, inspiring teacher as constitutes, it seems to me, his most perfect tribute and imperishable monument.

One of them, Dean Smith, of Sibley College, writes me: "My memory pictures Professor Sweet always at work upon something that should contribute to the training of the students in his charge; and no matter how busy he was, he was always ready to give his attention to any one who sought his instruction or advice upon any matter whatever." "One thing he said has always stuck in my memory," adds Professor Smith. "It is so characteristic of the man. He said: 'When you go out into practice you will not be paid for what you know but for what you can do.'"

Another of these former students, Mr. J. E. Johnson, Jr., has written a masterly appreciation of Professor Sweet which will shortly appear in *The American Machinist*. To it I am indebted for certain details and the extracts from Professor Sweet's reminiscences. Much stress is laid by his students on Professor Sweet's ingenious applications of graphics to replace the higher mathematics of his subject. Mr. Johnson mentions this interesting instance: On one occasion during a call from some professor the latter spoke of the very difficult problem in geometry which the mathematicians had just succeeded in solving, namely, that if three circles of different diameters are drawn in any position in a plane and a pair of tangents are drawn to each side of each pair of circles and prolonged to their intersection, the intersecting points of the three pairs of tangents will lie in a straight line. Professor Sweet thought this over for a few minutes and said: "Yes, certainly, I can see that that is true." The other professor said: "I guess you don't understand, Professor. This is a very difficult problem and we have just finally accomplished its solution. I don't think it is as obvious as you think it is." "Why, yes," said Professor Sweet, "of course it is obvious. Instead of three circles in a plane, take three balls lying on a surface plate. Instead of drawing tangents, imagine a cone wrapped around each pair of balls. On top of the three balls lay another surface plate. It will rest on the three balls and will necessarily be tangent to each of the three cones. The apexes of all the cones must lie in the intersection of two surface plates, and as the intersection of two planes is always a straight line, the apexes of the cones will lie in a straight line. It seems to me that this is perfectly obvious." So it was to a man who could think in those terms, but to how many of us, no matter what our mathematical training, would it be "obvious"?

At the Centennial Exposition in 1876, the notable feature of the Sibley College exhibit was Professor Sweet's Straight Line Engine, constructed at the college shop. As a marked departure in design from previous types, it attracted much attention; the more so since, when tested out, it developed a high efficiency. Encouraged by these facts, the inventor decided to leave the teaching profession and to devote himself to the manufacture of his engine in his home city of Syracuse. So the Straight Line Engine Co. was organized in 1879, with Professor Sweet as President—an office he held until his lamented death—and there Sibley College post-graduates and others of "Sweet's Boys" received their advanced practical training.

Many present, beside myself, must remember the kindly sentiment, "Visitors Always Welcome," cut in the stone over the entrance door of the factory, and, like myself, must have put it to the test more than once, only to find that welcome ever ready. And the straight-line engine itself was a familiar friend, too. We installed one in our first shop, Swasey and I, and used it until we needed more power. Then it passed to Brashear, in whose shop it is working steadily still—a tribute to the inventor's sound sense and feeling for right design.

Professor Sweet's name and fame became so well known that engineers and inventors made "a beaten path to his door."

It was his pleasure to commend and aid those who possessed merit. Just as ready was he to wisely direct those who came bringing heretical ideas in opposition to the fixed laws of mechanics. In such cases his keen sense of humor often played a kindly but convincing part. On one such occasion an inventor, after demonstrating an elaborate model, asked, "Now, Professor Sweet, what do you think of it?" Instantly came the characteristic reply, "Well, it seems to be a mighty good way to do a thing that doesn't need to be done." I recall, in the days when inventors tried to apply ball bearings to everything from bicycles to the axis of the earth, one such went to him to explain the merits of his new ball bearing for buggy axles. Professor Sweet listened attentively and then said to the proud inventor: "The ordinary buggy axle is of steel, about ⅞ in. diameter, nicely fitted to a cast iron sleeve and, presumably, well oiled. If you place such a buggy on a new, smooth floor, and with a sensitive spring scale, determine how slight is the power required to move it, you will see that, if your ball bearing saved it all, it wouldn't be worth while." He followed this statement by saying, "The resistance to moving vehicles is mostly on the ground and can be best overcome by making better roads." This now seems like propheey, in view of the fact that the State of New York has, since then, spent over one hundred millions of dollars in improving its roads.

Thousands of young mechanical engineers discover the great loss of power by the use of the crank in the steam engine and are then subject to attacks of the rotary-engine fever. Most of my hearers have doubtless prescribed for this malady and accomplished cures. So did Professor Sweet. For, when one thus afflicted came to him with a splendidly worked out design, the cylinder but half the usual circle, and enthusiastically invited his approval, Professor Sweet said cordially, "It is the very best rotary engine I have ever seen, for you have at the outset, thrown away half of it. Now all you have to do is to throw away the other half." Then we may be sure he gently put that young enthusiast back on the right track to real progress. This characteristic helpfulness to others held good to the very day of his death. For another of his "boys," Mr. Wm. C. Brown, tells me that on the morning of that day—it was the eighth of last May—a man from Texas, whom he had never heard of before, walked into the Professor's office to ask advice about a valve motion he had invented. When it had been explained but before Professor Sweet had an opportunity to express an opinion, his carriage came and he was obliged to go home to lunch, making an appointment for the man to return at a later hour. That afternoon the fatal stroke occurred and Professor Sweet was taken home by Mr. Brown, in the latter's car. On the way, though suffering intense pain, he told Mr. Brown about the stranger's errand and begged him to see the man when he returned and explain to him just why his valve motion was of no value.

Here is the great human note, without which even the harmonies of Heaven would be poor.

In these latter years Professor Sweet had enjoyed much travel. Of this he writes: "I have crossed the Atlantic fifteen times, have been in ten seas, twenty-two countries, and in too many rivers, bays and cities to enumerate. I have been four hundred miles South of the Equator and half way to the North Pole." So he took a warm interest in world politics, especially as affected by the present war of nations. This is the theme of several personal letters written to one of his very favorite "boys," Mr. F. G. Tallman. Recalling Professor Sweet's sentiments concerning the Civil War we are prepared to find him saying: "I have said, and said it years ago, that 'Prepare for war in times of peace' is the worst sentiment in the English language, and if anything was necessary to prove it, the present war does it. Men fight more for glory than anything else and there would be no glory in taking an unprotected country but a disgrace to the people who would do it. I believe this country would be in a safer condition without a cent's worth of arms, armaments and forts than with the best possible of those elements." These are vigorous words from a man of 82. Several letters are in the same vein. All express, at more or less length, his utter detestation of war and the specious excuses other men make for it.

As I turn the pages of this very private correspondence, kindly sent me by Mr. Tallman, I find one letter in quite another and a very amusing vein. I quote: "Some two weeks ago I got thinking about what was the first thing I ever made that I could remember about—and it was a boot-jack that I made somewhere about 1840, or when I was eight years old. And I called to mind the fact that I did then what I have always tried to do since—make it better than the ones made before." Then the writer tells how, being up at Pompey a few days before and mentioning the boot-jack, some one "went out in the wood-house and brought it in" and, he continues, "I have it now in my office. Wherein it differs from others is this: the old, or, in fact, all others, have a cleat under near one end, to hold that end up. In the place of the cleat, I have two holes through and put in two pins which I let project out from each side, so the jack is right side up whichever is put on the floor. As an evidence that it was used in the days of boots, the back end is worn tapering and the forked end has been worn by the boot heels. The point is that I did then what I have always tried to do since—*make the thing better*. But getting other people to adopt my notions has been as barren of results as my notions about preparedness."

Likewise, in his reminiscences, Professor Sweet writes: "I cannot call to mind ever starting on a job without thinking out how to make it better than it had been done before." The engineers of the world can set themselves no higher task than such a motto imposes, nor hope to accomplish it more fully and nobly than did Professor Sweet that which he undertook.

Simple and modest and self-effacing as he was by nature, honors sought him—not he them. In 1914 the John Fritz medal was awarded to him "for his achievements in machine design and for his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine." In the same year Syracuse University conferred upon him the honorary degree of Doctor of Engineering. But, as has been truly said, these honors, great as they are, are less lasting than will be "his influence over men, to cause them to think straight and live honorably."

The man of whom such things are true need make no claim of his own. In life he is revered. In death, we bring him the homage of our hearts.

The Chairman expressed the Society's indebtedness to Mr. Warner for this appreciative estimate of Professor Sweet. He then introduced another pioneer of the Society who was associated with Professor Sweet in his early days, Capt. R. W. Hunt. Captain Hunt said in part:

CAPTAIN HUNT'S TRIBUTE

"Blessed are those whose works are such that every day and every moment of that life has been to make their fellow men better and happier, and such was Professor Sweet. His life was as simple as his mechanical ideas, and just as accurate in its greatness and in its purity. To know him was to be blessed, and certainly his influence exerted upon those who came in contact with him, and left as a beneficence to those who follow him, is of a character that makes the world worth living in.

"His achievements were not of a startling kind. His successes did not bring to him great fortune, but each one made men better and happier, and the fact that following the years of his teaching he established a brotherhood of love among men who continued to pay tribute to him until the day of his death was an achievement of which any man should be glad and proud, and sufficient to content any man."

The Chairman then called upon Prof. Albert W. Smith, Dean of Sibley College, Cornell University, who was one of the Sweet boys in the early days of Cornell, and was afterward superintendent of the Straight Line Engine Works.

DEAN SMITH'S TRIBUTE

Professor Smith said he counted it one of the pleasures and privileges of his life that Professor Sweet was his teacher in Sibley College and his employer in the Straight Line Engine Works, and that there were two things which characterized his knowledge of Professor Sweet: *first*, his clearness of thought, and, *second*, his deep human sympathy. Dean Smith continued:

"As I said once before in public, Professor Sweet all of his life carried a little sharp needle to prick hot-air balloons, and then when he saw the balloon collapsing, his sympathy for the man who had brought it to him was so great that he would explain to him a way to blow balloons so that they could not be punctured.

"I want to tell one story that has not been told here this morning. The Professor was especially proud of the Straight Line engine because, although it was a high-speed engine, it ran silently. One day a man from Syracuse came to the works, and a Straight Line engine was on the skids ready to be shipped. This man was not an engineer. He came in and the Professor greeted him, and he said to the Professor, looking at this engine, 'I see you are still making drop hammers.'

"It seems to me that in human life there is only one cardinal sin, and that is selfishness. All others are simply outgrowths or modifications of this one sin. It is the one of which Professor Sweet was guiltless all his life, for he was the kindest and most unselfish man that ever offered help and sympathy to harrassed human mortals. I am proud of the fact that it was given to me to be one of Sweet's Boys."

The Chairman in conclusion said that it seemed proper to those who knew Professor Sweet and loved him so dearly that this memorial should be characterized by extreme simplicity and brevity, and with these tributes the service closed.

MISCELLANEOUS SESSION, WEDNESDAY MORNING

AT the first Miscellaneous Session of the Annual Meeting, at which Dr. D. S. Jacobus presided, the following five papers, contributed by local Sections of the Society during 1916 and published in The Journal, were read by title:

Steam Safety Valves, George H. Clark, contributed by the Boston Section.

Efficiency of Propulsive Machinery and Late Developments in Naval Engineering, H. C. Dinger, contributed by the Philadelphia Section.

Standardization of Power Plant Operating Costs, Walter N. Polakov, contributed by the New York Section.

Report of Efficiency Tests of a 30,000-kw. Cross-Compound Steam Turbine, H. G. Stott and W. S. Finlay, Jr., contributed by the New York Section.

The Design and Test of a Large Reclamation Pumping Plant, G. C. Noble, contributed by the San Francisco Section.

MR. ORROK GIVES FORMULÆ FOR THE PROPORTIONING OF SURFACE CONDENSERS

George A. Orrok then presented a paper entitled The Proportioning of Surface Condensers, in which he enunciated the following principles:

a The law of temperature rise in a condenser tube is of the exponential form, with 0.875 (0.9 or 0.8, perhaps) as the exponent

b It is not necessary to take viscosity into consideration in designing where the water temperature is 65 to 70 deg. fahr. and the vacuum is 28 in. or over

c Critical velocity may likewise be neglected, since all condenser velocities are far above it

d For velocities obtaining in condenser practice the coefficient K may be taken as the 0.6 power of the velocity

e The reduction in heat transmissive power due to the presence of air in a condenser is very approximately covered by the use of a term $(P_s \div P_v)^2$ as a reducing factor of K

f For design work the value of K may be reduced once for all to account for the cleanliness of the tube and the material itself

g The value of K will then be reduced to somewhere between 300 and 400 for design purposes, say 325 for average good working.

Mr. Orrok presented the following formulæ covering the application of the results of his experiments to the design of surface condensing apparatus:

If P_v = absolute pressure in condenser = 29.92 — (vacuum + 0.2 in.)

t_s = temperature of steam corresponding to vacuum

t_0 = initial temperature of condensing water

t_1 = final temperature of condensing water = t_s — 5° for close work, ordinarily = t_s — (7° to 10°)

λ = total heat of steam at t_s

q = heat of the liquid at t_s

Then, ratio of condensing water to steam condensed is

$$R = \frac{\lambda - q}{t_1 - t_0}$$

Also, pounds of steam condensed per hour = W, and weight of condensing water used = $Q = WR$.

One-inch tubes (No. 18 B. W. G.) being taken as standard on account of advantages generally conceded to that size, the number required in one pass = $n = Q \div 990 V_w$, where V_w is the velocity of flow, averaging 8 ft. per sec. (7 to 10 ft.).

The length of water travel (l), or the total tube length, may be found from

$$l = \frac{30.8\,Q}{325\,V_w^{0.6}\,n}\left[(t_s - t_0)^{0.125} - (t_s - t_1)^{0.125}\right]$$

and the total tube surface (S) from $S = 0.262\,\pi dl$.

The cross-sectional area of the condenser (sq. ft.) is equal to ($n \times$ number of passes) $\div$ 60, where 60 is the average number of tubes occupying 1 sq. ft. of tube-plate area. The length of the condenser = $L = (l/m)$ + depth of water boxes, where m = number of passes.

The author said, in presenting his paper, that the data in it were ten months old, but that he had heard of no experiments since which would cause him to change anything in the paper. He said that at the present time we unfortunately lack experiments to confirm our conclusions regarding the air question, and there might one or two things come up within the next few months to cause him to change his opinions. If so he would come back later and say that his paper was no longer correct.

William Kent, in opening the discussion, said he had no fault whatever to find with this paper, except that it needed an appendix, and he hoped Mr. Orrok would next year give another paper supplementing this one.

The principal question he wanted answered was: Given, say, a 1000-hp. engine, with 10 lb. of steam per horsepower, which would make 10,000 lb. of steam, and with 29.5 in. of vacuum and 70 deg. fahr. temperature of circulating water, how many square feet should be put in the condenser, and how should the square feet be arranged? The temperature of the condensing water, the vacuum, and the number of pounds of steam to be condensed are the only things we have to begin with, and the two things to be found are the number of square feet and the arrangement of the heating surface.

Wm. D. Ennis thought that if the author would explain the statement: "The law of temperature rise in a condenser tube is of the exponential form, with 0.875 (0.9 or 0.8, perhaps) as the exponent," the surface capacity could be readily determined.

Thomas C. McBride said that a number of condensers had been built in which the circulating water was heated in the neighborhood, taking an actual instance, of from 70 to 95 deg., but now we find it desirable to force a lot more water through and lower the average water temperature and thereby increase the total amount of heat transmitted per square foot. That brings up the question of the length of tube possible with the increased amount of water, as it influences the horsepower of the circulating pump.

He put up on the blackboard his own equation for determining surface, which checked up because with it the amount of surface multiplied by the length traveled through by the water was constant.

Geo. H. Gibson and Paul A. Bancel wrote that they thought that the author has given more attention to the devising of algebraical formulæ than to explaining the fact, which is clearly patent, that single-tube experiments and practical condenser results are 100 per cent or more apart.

Values of the coefficient K varying from 470 to 630 are mentioned as experimental results. Upon proceeding to put down principles which can be used in designing, however, the author says "The value of K will then be reduced to somewhere between 300 and 400 for design purposes, say 325 for average good working." As a matter of fact, coefficients equivalent to 300 have been attained for years in old-fashioned condensers without the grace of new-fangled formulæ and with tubes packed 100 or more to the square foot and only 3 or 4 ft. per second water velocity, whereas the author recommends about 69 tubes to the square foot and 8 ft. per second water velocity. If all the new formulæ get us no farther than this, why formulate?

The conclusion is unescapable that what takes place in an individual tube surrounded by pure steam is, in the actual condenser, submerged and obscured by some other factor or factors. Has sufficient study been given to the flow conditions on the steam side of the tube?

Just as there is a best tube length for the water flow, so there is a best tube-bank depth for the steam flow. As condensers grow in size, it is not correct merely to make them deeper in proportion as they are made wider. The best depth must be determined and increased capacity obtained by spreading out in the other dimensions. Steam lanes in the tube bank do not solve the problem, for they are like by-passing water directly from the cold-water box to the warm-water box; some of the heat-transmitting surface is by-passed by the lanes and becomes stagnant and inactive because of accumulation of air. Another solution which has been proposed, viz., to keep every tube in the condenser bathed in pure steam summer and winter, heavy loads and light loads, by pulling a larger proportion of the steam through into the air pump, leads to an excessive power consumption by the latter.

Mr Bancel supplemented the above discussion by considering the effect of size of condenser on efficiency. He said that condensers are getting bigger and bigger nowadays, and it has been assumed that the condenser would be more efficient in large sizes. One reason for this was that the turbine is more efficient in large sizes, but the problems that come into condenser design are very different from those that enter into the case of the turbine.

M. C. Stuart presented a comprehensive written discussion in which he gave the results of his own analysis of the author's data. Some of Mr. Stuart's conclusions were:

"Undoubtedly the data presented show conclusively that the heat-transfer factor did vary as a function of the mean temperature difference between steam and water. The runs used to reach this conclusion, however, included only those in which the steam temperature was constant and the inlet-water temperature varied. A set of runs may sho wthat the heat-transfer factor varies with the temperature difference, but this does not mean necessarily that the variation is *because* of the temperature difference. At constant steam temperature, small temperature differences correspond to high actual water temperatures, and it is altogether possible that the variation obtained by Mr. Orrok was due to the variation in actual water temperature, rather than to the variation in temperature difference.

"I agree that for the narrow ranges of temperature existing in condenser work (from 70 to 90 deg.) the effect of viscosity need not be considered. It would also appear that the effect of varying temperature differences need not be considered, especially in view of the evidence that the heat-transfer factor varies with actual water temperature and not with temperature differences.

"As to the relation of heat-transfer factor and velocity, I find that the plot of velocity *vs.* heat-transfer factor on log paper gives a line which is decidedly curved, and which indicates an exponent varying from 0.5 to 0.6 in the formula $U = C\ V^x$ over the velocity range from 2 to 8 ft. per sec."

"The author chose 8 ft. per sec. velocity only because this is usual. At a velocity of 8 ft. per sec. the friction drop amounts to 10.73 ft. of water and the total length of tubing amounts to 3250 ft. per million pounds of water per hour. By increasing the velocity to 12 ft. per sec. the total length of tubing may be reduced to 2570 ft. at the expense of an increase in the friction drop to 25.24 ft. of water. The writer is not advocating the use of any particular velocity, but simply placing emphasis upon the fact that the proper choice of a velocity should be given more consideration."

G. L. Kothny, in a written discussion, stated it would be interesting to hear what amount of air leakage in pounds per hour should be assumed per 100 sq. ft. of surface when using 325 as the value of K. He thought an attempt should be made by condenser manufacturers to agree on the maximum and minimum amount of air leakage permissible for certain sizes of condensers, and that the establishment of such standard figures would give a better basis for comparison of the efficiency of different types of condensers. It would be interesting to hear from Mr. Orrok if he has any data referring to the maximum and minimum amounts of air leakage in pounds per hour for different sizes of surface condensers, such as 5000, 10,000, 25,000 and 50,000 sq. ft. cooling surface.

He suggested that, to avoid misunderstandings, the symbols used for making condenser calculations should be agreed upon or determined by a standard committee of members of the Society engaged in condenser work.

Alphonse A. Adler entered into a lively discussion of the formula given by Mr. McBride, criticizing it on the score that it was physically inconsistent. Professor Kent and Mr. McBride joined in and the discussion became a question of meaning of a dimensional formula.

The author said in reply to the query of Professor Ennis regarding the exponent $\frac{7}{8}$, that in the closure to the discussion of his paper before the Society three years ago he showed three dimensional diagrams which would make clear what he meant.

What we would like to know about a condenser is whether, plotting the temperature rise of the water against the length of the tube, the arithmetical rise is true, the logarithmic rise is true, or the exponential rise is true. On that depends the whole mathematics of the thing. The reason this is non-dimensional, as Professor Adler says, is because it works on the arithmetical mean. You can have a thousand tubes one foot long, or one tube a thousand feet long, and get the same result in the condenser.

He thought Mr. Gibson had mistaken K for U. K is the coefficient, while U is the heat transfer, and that makes a big difference. The heat transfer is two, three or four times what the coefficient is. We get heat transference in a single tube up to 1200 to 1400, and in the condenser up to 700, 800 or 900, but the coefficient is rarely much over 400. The reason why we cannot get the high coefficient at low load on the condenser is that we do not have the heat to transmit. We have a large temperature difference, and therefore the value of U to the coefficient is very small always owing to that.

As to the depth of the tube bank, he said he would like to go into the question of the velocity of steam amongst the tubes, but it was a long subject and was covered pretty well in his original paper.

Regarding the criticism as to the velocity of water he took

in the tubes, he said he had assumed the customary velocity. The actual velocity to choose is a commercial question, depending on how much you are willing to spend for pumping power.

PROF. BRECKENRIDGE AND MR. PRENTICE PRESENT PAPER ON TESTING HOUSE-HEATING BOILERS

The second paper presented at this session was by L. P. Breckenridge and D. B. Prentice, on The Testing of House-Heating Boilers. In this paper the authors proposed a standard method for testing this class of boiler, a type of apparatus which has not yet received the attention of the Power Test Committee of the Society. The paper was presented by Mr. Prentice.

James W. Nelson made a motion that this paper be referred to the Power Test Committee of the Society for consideration for incorporation in the Rules for Conducting Performance Tests of Power Plant Apparatus, which was seconded and carried.

Geo. H. Barrus, C. M. Garland, Roy E. Lynd, C. B. Thompson, Max Friedlander, Allen Hubbard and William Kent contributed written discussions to this paper, the salient points of which follow:

Geo. H. Barrus, as a member of the Power Test Committee, thought it might be taken for granted that the Committee would welcome any suggestions for amendment to the Power Test Report such as the authors brought forward. He hoped, furthermore, that this paper would lead other engineers to study these codes with a view to pointing out any possible deficiencies.

C. M. Garland stated that this type of boiler and furnace has been notoriously uneconomical in the appropriation of the heat liberated by the fuel, and it is largely due to Prof. Breckenridge's initiative along these lines that the inefficiencies of these boilers have been brought to the attention of the manufacturers, engineers, and to the government experiment station. The result is that manufacturers have given the matter of efficiency serious thought, and house-heating boilers of excellent efficiency are now built.

The testing of this boiler is radically different from the testing of the high-pressure boiler as used for power and larger heating work. It is therefore desirable that a different code should be provided for the testing of these boilers. The one proposed by the authors would seem to meet the requirements of the different conditions. A heat-value unit for a standard measure for one foot of radiation would be a most desirable standard.

Roy L. Lynd was satisfied that tests made by competent engineers in accordance with the code outlined would be about as complete and accurate as it is possible to get them.

He thought it would be well to eliminate the term House-Heating Boilers from the code, and substitute Low-Pressure Heating Boilers.

As the proposed testing code is essentially a code for evaporative tests, we are not concerned with boilers for hot-water heating and hot-water supply. The new code should therefore cover all boilers used exclusively for steam heating and should be so entitled. The A.S.M.E. Boiler Code in Section 2 does not limit low-pressure heating boilers to 2000 ft. or less, and we should not so restrict the testing code.

He criticized the authors' definition of a foot of radiation, and suggested that a better arbitrary value than 242.6 B.t.u. per hour would be 250 B.t.u. per hour.

C. B. Thompson wrote that, if he had read the paper understandingly, its argument was that boilers are overrated because there has been no well-established or standard testing code, and hence errors in tests have led to errors in computing working capacities. With this he could not agree, as the code presented is only one of many by which boilers may be tested that will show practically the same results. It is when the tests are computed to determine the boiler's capacity in terms of square feet of radiation that guesswork is employed. The computer can give the capacity at which the boiler will operate for any unit of time if he knows the full capacity. Without this all-important item he is adrift in a fog.

If the capacity of house-heating boilers were computed something like the following, there would be less complaint of overrated boilers, because many buyers do not understand that the rated capacity is at the boiler outlet:

	Sq. Ft.
Capacity Cast-Iron Radiation	800
Add for Covered Pipe	150
Total Boiler Load	950
Coal will last, hours	9

Then give the chimney size required and the purchaser can select what he wants without outside assistance.

Max Friedlander, in his written discussion, contributed a new method for a *continuous* determination of the heat balance of house-heating boilers, which, so far as he knew, had not yet been published elsewhere. A description of this method will be given in a later issue of The Journal.

Allen Hubbard considered, in his written discussion, that if the manufacturers would rate their boilers on the basis outlined by the authors, the public and the business generally would be greatly benefited.

William Kent thought that the method of rating proposed seemed to leave out a most important factor—the grate surface, or the amount of coal that should be burned per square foot of grate surface.

Mr. Kent also proposed the figure of 250 B.t.u. for the square foot of radiation, instead of 242.6. This figure has long been used by heating and ventilating engineers as a standard equivalent for an average square foot of radiation.

The author promised to reply to the discussion in a written closure, which will be published later.

WATER PURIFICATION VS. BOILER COMPOUNDS DISCUSSED IN PAPER BY MESSRS. SCOTT AND BAILEY

The third paper presented at this session was that by Arthur C. Scott and J. R. Bailey, on Water for Steam Boilers—Its Significance and Treatment. The point in this paper was that the use of *boiler compounds*, except in plants of relatively small size, is less efficient and more expensive in preventing trouble than methods employed for the water purification before it enters the boiler.

William Kent objected to one statement in the paper, that the waste of fuel in a boiler caused by scale is proportional to the thickness of the scale, and claimed that the author's figures illustrating this were fifty years old and, moreover, rested on no authority whatever. He stated that the loss in heat due to scale on the tubes may be absolutely insignificant.

He commended what the authors said in condemning boiler compounds, but thought this statement might have been made even stronger.

W. T. Alliger[1] commented on the statement: "As a matter of fact, purification of water is partially obtained in most

[1] Harrison Safety Boiler Works, 17th St. & Allegheny Ave., Philadelphia, Pa.

cases by heating it to the approximate boiling point, but the hot process assumes that with steam enough to give a temperature of 200 deg. fahr. or over, sufficient soda ash is added to the feed water to just satisfy the alkaline earth sulphates and chlorides and any acid present, and the water is then satisfactorily purified." That might have been true several years ago when the practice was low temperatures with very little overload. But with the present development in boiler practice, where we carry very high overloads and high steam pressures, the statement is not correct. With the present practice, we require water as good as can be obtained, consistent with the amount of money we can spend in getting the results. In the most efficient plants they have even gone so far as to evaporate the make-up water, but in ninety-nine plants out of one hundred that is not permissible for economic reasons.

With a hot-process system you can get better results in purification than by any other means. In many cases he had seen results where the scale-forming impurities have been reduced to as low as one grain, in one case to half a grain, and in some others to about three-quarters of a grain. These results are controlled by the temperature. If you can operate your hot-process water softener under slight back pressure, say up to 5 lb., the results will be improved.

The authors take up the question of foaming, but there is probably as little known about the causes of foaming, as little proved on the causes of foaming, as anything connected with the operation of boilers. Personally, he was inclined to believe that the collection of suspended matter at the surface of the water has a greater influence on foaming tendencies than the constant breakings of the soluble salts, provided they are kept within reasonable limitations.

Written discussions of this paper were presented by Geo. H. Gibson, M. F. Newman and F. F. Vater, respectively.

Mr. Gibson considered that present water-softening practice was well summarized by this paper, except that the authors did not appear to be familiar with the latest development in hot-process softeners, which have made a radical advance, due to recent improvements in chemical feeding devices. Milk of lime is now fed as easily and as accurately as soda or caustic soda, or trisodium phosphate could be fed before. That chemical or combination of chemicals which will give the desired results at the least cost, all operating conditions being taken into consideration, can therefore be used in all instances.

Chemical reactions are much more rapid and complete in hot water than in cold water, as any one can satisfy himself by taking a sample of water, dividing it into two parts, heating one sample to the boiling point while leaving the other cold, and then adding to each the exact amounts of softening reagents theoretically required for the transformation of the scale-forming substance. There will immediately appear in the hot water a coarse, granular precipitate, which soon settles to the bottom. With most natural waters, no effect at all will be apparent in the cold water for ten or fifteen minutes, and even then only a slight haze. In due time a very fine precipitate will begin to come down, the sedimentation becoming complete, however, only after four to six hours. Even then, if the cold sample be heated to boiling, further precipitation will occur. This action is frequently observed where water from cold-process systems is passed through feedwater heaters.

In the hot water, complete reaction is also obtained with a smaller excess of reagent than in cold water, and overdosing is not necessary in order to reduce the total solids closely to the limit imposed by the solubility of the end-products, that is, of the substances into which the scale-forming matter is transformed by the chemicals. In fact, the manufacturers of hot-process softeners regularly guarantee to reduce scale-forming solids in solution to less than 2½ grains per gallon, and in actual practice the total solids in the treated water are frequently reduced to below 1 grain per gallon, sometimes to less than ½ grain per gallon.

The discussor here described an apparatus by means of which the softening reagents are fed with great accuracy and sensitiveness and which has been developed from his suggestions by the Harrison Safety Boiler Works, of Philadelphia. The description will be published later.

F. F. Vater's discussion was a defense of the hot process of water softening, which, he said, offers possibilities not obtainable by the cold process. He objected to the author's classifying this process with such devices as live-steam purifiers and boiler compounds, on the ground that the cold process would be more appropriately classified with these.

M. F. Newman, on the contrary, claimed that the most highly efficient water purification is carried on without dependence upon heat. The main factors in boiler purification, he wrote, are not heat, soda ash and blowing, with possible filtration, but accurate softening and purification carried out independently of the variables encountered in the irregular flow of water through the heater and the uncertain degree of precipitation within the heater. The authors attributed foaming and priming chiefly to a concentration of alkali salts, giving secondary consideration to silt, organic matter, loosened scale, lubricating oil, etc. It had been found, however, that in the absence of substances in solution which form precipitates upon concentration, water containing alkali salts could be highly concentrated without any appreciable effect on the steaming quality of the water.

This writer also discussed in a comprehensive manner a number of other points in the paper, and his discussion will be published in extended form later.

The discussion of Messrs. Scott and Bailey's paper was continued at the Miscellaneous Session on Friday morning, when Geo. L. Fowler discussed the paper orally.

Mr. Fowler said that it seemed to him that all of the formulæ given by the authors were such as could be found in any book on water softening. Ordinary ingredients like carbonate of iron and magnesium and sulphate of lime and magnesium we have known how to treat ever since Clark published his famous work almost a century ago. It seemed strange to him that one of the authors should have skipped over the ingredient which occurs in almost all boiler water—organic matter—which, in his opinion caused more trouble in such waters than anything else. He instanced the case of a certain railroad in which the metal in some boilers corroded very rapidly under conditions apparently the same under which other boilers did not corrode at all. It was naturally suggested that the fault was with the metal. In some cases this was found to be so, but in others, upon analysis of the boiler water, the latter was found to be no more like the feedwater than black is like white. Something resembling an alkaline solution was found to be in the water.

Building a small boiler and evaporating the analyzed water in it revealed the fact that the trouble was with organic matter in the water, which decomposed under high steam pressure.

Mr. Fowler thought that every case of boiler feedwater needed special attention. An analysis of the raw water could not be trusted to, and the only thing to do was to see what was going to happen to the water when it was evaporated under the same conditions to which it would be subjected in the boiler.

INDUSTRIAL SAFETY SESSION, WEDNESDAY MORNING

At this Session of the Annual Meeting there was presented for consideration a Proposed Code of Safety Standards for Cranes, which had been prepared by committees selected from a large number of representatives of important industrial interests and of insurance companies, inspection bureaus, etc., under the direction of the Industrial Commissioner of Pennsylvania. The Code in question is intended primarily for electric traveling cranes, but its provisions are designed to cover jib, monorail and hand-power cranes insofar as the various sections apply. The first half of the Code deals with details of design and construction, and the remainder with rules for crane operators, floormen, and repairmen.

In opening the Session, Chairman John H. Barr announced that the policy of the Sub-Committee on the Protection of Industrial Workers, under whose auspices the Session was held, was to confine itself strictly to the preparation of codes for safeguarding machinery, leaving propaganda work on the safety movement to other instrumentalities. The Code presented was to be considered a basis upon which should be finally developed a Code that would be adequate, make all necessary provisions for safety, and at the same time not be so drastic as to be beyond reason. The hope of the Committee was to formulate Codes that would be adopted and approved by state governments, resulting in uniformity of legislation. With the latter obtained, manufacturers would be quick to build in the safeguards which are now left to the user to provide.

At the request and in the place of Dr. John Price Jackson, who was unavoidably prevented from being present, Prof. A. M. Greene, Jr., then read the text of the Code in full. Commenting thereon, he expressed the opinion that the factor of safety of 5 specified for parts other than gears and complete hoisting mechanism was rather low, unless allowance was made for impact. He also believed that the reference to the use of cast iron for brackets should be limited to brackets supporting shafting, and that the specific purpose for using wire mesh should be stated. He desired to ask if a gong that automatically sounds when a crane is in operation would be advisable, and also just what the meaning of "properly" was in the expression "properly lubricated."

In a written communication, R. W. Hicks suggested that the word "approved" used in several paragraphs of the rules for general construction be omitted altogether, or that authority of approval be vested in some organization suitably equipped with apparatus to determine the merits of various devices that are apparently acceptable.

H. M. Mowery submitted a brief written discussion urging that, in view of the slipping hazard, the Code include a statement to the effect that "All tread surfaces, and particularly stair treads, shall be so constructed and maintained that slipping on them will be prevented."

Replying to the queries of Prof. Greene, R. A. Medina[1] stated that the recommendation of a safety factor of 5 represented the consensus of opinion of the Committee. In regard to using cast iron for brackets, he thought it would be well to employ a modifying adjective in order to avoid any misunderstanding. He explained the use of wire mesh in covering openings and thus preventing bolts, tools, etc., from falling to the floor below. He thought an automatic gong, sounding all the time, would have little effect, as the men would soon get used to it and ignore it.

Henry A. Hale, Jr., remarked on the absence of any injunction in the Code as to the type of hook to employ in hoisting a load. In his opinion, the hook should be of an improved type, having, if possible, a handle at the back so that the floormen would not have their hands squeezed or crushed in attaching it to the load. As to manual signals, he thought that they were not apt to attract much attention, particularly when the crane operator was at some considerable distance from the man signaling; and it was very desirable, therefore, that whistles of a proper sort be used in such work.

Prof. F. R. Hutton called attention to several places in the Code where the English might be improved and ambiguities removed. He found that in one place a factor of safety of 5 or 8 was specified and in another that for the brake drum it should be 1½. Either it should be stated that the apparatus designed has the factors 8 and 5, with the exception of the brakes, or that brake factor of safety does not come under the limitation of the earlier paragraph. In the paragraphs dealing with warning signals, it should be made plain that "approved" means "approved by State factory inspectors." With respect to the provision of guards for gear wheels, he was of the opinion that the idea would be more strongly presented by specifying that standard guards should be provided to all existing cranes where practical. Replying to Prof. Greene's query on the paragraph dealing with lubrication, he thought that it would be well to omit the word "properly," leaving it to the foreman to see that the work was done satisfactorily. Referring to the provision that hoisting brakes should be tested, he thought it desirable that the frequency of such tests be specified. He found that in two of the rules the word "hitch" was used. To his mind, while "sling" was a much more general term, he believed it would be better to use both words.

The Chairman, commenting on the remarks of the preceding discussor, thought that the word "hitch" was more comprehensive than "sling," and would include both the operation and the appliance used. But it was well in such things that there be no confusion as to the meaning intended.

A. D. Risteen said that in his opinion the Code should include instructions in regard to starting to lift loads gently. Also, that the highest object over which the crane had to pass should be painted white on the top, so that it would stand out conspicuously against the miscellaneous background of dark objects underneath.

It was stated by H. M. Elder that in the works of the American Locomotive Company the crane operator is signaled to by means of an air whistle; the operator knows the location of this whistle, and looks and sees the man giving the signal. With regard to starting to lift loads gently, it would hardly do to specify this, as it would prevent those having a.-c. crane motors from using them. As to equipping with an approved limit switch, he had to say that his company had experimented with a number of such devices, both purchased and of their own construction, and had not yet found one that satisfied the crane operator and the electricians.

A. H. Blaisdell thought that gongs were often likely to be unheeded and that it was good practice to have the floorman precede the load and warn people out of the way. He believed that a crane out of order or under repair should have a red flag hanging from it; that a crane operator should be

[1] With Independence Inspection Bureau, 137 S. Fifth St., Philadelphia, Pa.

provided with a megaphone, and that there were advantages in using hooks that had been painted white, especially on night shifts.

According to J. W. Upp, it was very evident that both manufacturers and users of apparatus were earnest in their efforts to safeguard the workmen, and to provide apparatus that would give the maximum of protection without unnecessary complications. As a manufacturer he was interested in the discussion, for everything that could be done to make uniform the regulations governing any class of apparatus was a distinct help to the user.

Prof. F. R. Hutton spoke of his visit earlier in the week to Washington, at the instance of the Council, to represent the Society at a conference summoned by the State of Ohio and its officials and the Labor and Factory Commission. Here he was informed that little by little the Ohio State Boiler Code was being withdrawn and that promulgated by the Society being advanced all the time, and that it would be but a short period before the A.S.M.E. Code would be the only one used. The whole atmosphere of the session was so definitely favorable to the incorporation of the technical recommendations of the Society, that it looked to him as if very substantial progress had been made along the line of recognizing that the Society was a body which, by its position and methods of arriving at results, was free from many of the difficulties that often came up to trouble legislators, where they were not sure that business organizations were not behind recommendations with respect to the scientific principles or facts underlying a Code.

In closing the oral discussion as the representative of Dr. Jackson, Mr. Medina stated that the Code had been purposely drawn in a broad and general manner, for the reason that a very specific code would be at the same time very bulky. In Pennsylvania, to his knowledge, no limit-switch device had been approved by the Factory Department, possibly because the Code had not officially gone into effect. Undoubtedly, however, the Department would soon have to say "yes" or "no" to various devices now available. He agreed with Mr. Elder that it was exceedingly difficult to find a limit switch that met the needs of everyone interested, and thought that this was a matter upon which the Committee could well afford to hold a separate session.

MISCELLANEOUS SESSION, WEDNESDAY AFTERNOON

AT the second Miscellaneous Session of the Meeting, which was also held in the Auditorium, and at which Dr. Jacobus presided, three steam-plant papers and two papers relating to the flow of fluids were presented and discussed. One of the steam papers, that by Victor J. Azbe, was one of the two papers recommended for honorable mention in the Junior Prize Paper contest for 1916.

MR. PRATT REVIEWS PRACTICE IN THE UTILIZATION OF WASTE HEAT IN GENERATING STEAM

The first paper presented was by Arthur D. Pratt, entitled The Utilization of Waste Heat for Steam-Generating Purposes. The paper dealt with the principles underlying this subject and gave a general survey of what has been accomplished in this line in which it is today possible to generate steam successfully from gases whose temperatures are as low as 950 or 1000 deg. fahr. It also considered the problems involved and the results obtained with waste-heat boilers in connection with copper-refining furnaces, cement kilns, open-hearth steel furnaces, beehive coke ovens, zinc-refining furnaces and furnaces of various types, both generative and non-generative.

Alex. G. Christie said that in connection with the cement-mill work, the noteworthy point brought out in the paper is that there is not only a large reduction of fuel consumption by the utilization of this waste heat, but also a better dust recovery, and in some sections this latter is a question of considerable importance.

The performance of waste-heat boilers described seems to depend largely on high gas velocity being maintained by an induced draft, and that, naturally, leads one to question whether the same principle could not be applied to the standard boiler.

Three written discussions of Mr. Pratt's paper were presented by L. D. Ricketts, Warren B. Lewis and B. N. Broido, respectively.

Mr. Ricketts' discussion was a confirmation of the conclusions of the author regarding two of the installations described in the paper, supplemented by information concerning the amount of power recovered at a typical waste-heat plant.

In Mr. Lewis' discussion was given a description of a plant using waste-heat boilers in which the transfer rate is low, illustrating the other extreme from the plants described in the paper. In connection with the heat-transfer rate Mr. Lewis wrote: "It is true that the velocity of fluids over heated surfaces is a great factor in the transfer rate; it is also true that the greater the velocity the greater the pressure drop, and that the amount of the pressure drop allowable is determined by the cost of producing that pressure drop. Furthermore, the use of a high transfer rate is to reduce the cost of installation, and the reduction so obtained must be sufficiently great to offset the increased cost of power employed in overcoming the excess pressure drop."

Mr. Broido wrote that waste heat is also very often used in Germany to superheat steam; that in cases where, for some reason, superheaters cannot be installed in the boilers, or circumstances require the superheater to be near the engine, independent superheaters are recommended, and in such cases superheaters heated by waste gases are the ideal installation; they do not need the frequent and careful attention which independent superheaters with their own furnaces require. The superheat temperature can be easily and quickly regulated with a damper in the gas inlet. The superheater pipes remain permanently clean outside.

This writer gave a description, with illustration, of a superheater system he had designed and installed for utilizing waste heat from coke ovens and open-hearth steel furnaces.

MR. PIGOTT DESCRIBES GRAPHIC METHODS OF ANALYSIS USED IN DESIGNING STEAM POWER PLANTS

R. J. S. Pigott presented the second paper of the session, entitled Graphic Methods of Analysis in the Design and Operation of Steam Power Plants, a proposal for designing power plants based upon anticipated load curves, which he introduced in the following terms:

"This paper is the outcome of an attempt to standardize to some degree the process of designing steam-power plants. For the past few years I have been engaged practically exclusively in power-plant work, and what struck me, up to the time when this method which I am to present was developed, was what you might call the sloppiness in the methods used in designing steam power plants. Most of the problems have been settled by opinion rather than fact, by inference rather than methodical pursuit and analysis, and inasmuch as we are spending so much time nowadays in systematizing our management in other directions, there is no reason why we cannot systematize and standardize our method of designing a thing like a power plant.

An attempt was made, therefore, to utilize the water-rate curves and input-output curves to a greater extent than heretofore, and to combine them. The method is based on the use of the input-output curve for each piece of apparatus employed in the plant. It is not sufficient to take the isolated loads on separate apparatus to determine what will be the B.t.u. consumption per kw-hr. of the combined plant. If you are to find out what is the change occurring with a variation of load factor or variation of maximum load, you must find out what is the combined variation in units making up the plant, and the only way that this can be done with any sort of simplicity is graphically."

Walter N. Polakov called attention to several other methods than that of using the Willans lines as advocated and used by Mr. Pigott. He said that the limitation of analysis of the prospective working of a power plant which is contemplated to be built for New York City purely by the Willans method has the disadvantage, which Mr. Pigott touched upon himself, that it does not cover entirely other factors, for instance, financial factors, that are just as important and sometimes more important than the thermal efficiency of the equipment of the plant.

Norman G. Reinicker said he had used the same scheme the author proposes without quite so much trouble, by plotting the feedwater demand, as indicated by venturi meter readings for the same load over various numbers of days, and he had found that the effect of putting on another turbine would show up in that curve. This method saves the testing of various machines, and gives a rough calculation, at least. The graphical method is valuable where you can predict the load curve accurately, but in some plants it is hard to predict what may be expected.

James W. Parker said that the assumption had been made that the purpose of an auxiliary power system in a power plant and of the feedwater arrangement is primarily to obtain auxiliary power. The problem, as he saw it, is to heat your feedwater under all situations. At all times it is desirable to generate as much auxiliary energy as possible in the heating of your feedwater. If it is possible during the period of light load to take power for your auxiliaries from the main bus, and during the period of heavy plant load to transfer that from the auxiliary generator, if you have such an installation, to the main bus, you can use your main electrical system as a reservoir for the storage of energy, so to speak, and at all times have the cream of your auxiliary steam turned into auxiliary energy.

Two particular statements of the author brought out considerable discussion. The first of these was that in the Remington plant the average flue temperature for the month was below 400 deg. fahr., and in a case such as this a fuel economizer is out of the question. The second was that in the case of the Interborough plant the economizers were already installed and were removed simply because they obstructed the draft, and the high ratings required meant that they would have to be eliminated for the sake of the draft.

Dr. D. S. Jacobus and Messrs. Albert A. Cary, George H. Gibson, Sherwood F. Jeter, James W. Parker and Arthur M. Greene, Jr., participated in this discussion.

Joseph Harrington took up the question of size of combustion chamber which the author had said he had studied and which he cited as an additional factor in getting the flue-gas temperature down so low.

Albert A. Cary thought that the size of combustion chamber is not a fixed quantity but should be varied according to the amount of volatile matter in the coal.

The author replied to the various points raised in the discussion. As to the question of size of furnace, he said this depended more on how well you were mixing your gases and how long they were allowed to stay at high temperature before throwing them against the comparatively cold boiler tubes.

In reply to Mr. Polakov, he said that in one example in the paper an attempt had been made to make the graphical method cover the financial end. The maintenance and labor were considered and were balanced against the fixed charges.

MR. AZBE MAKES POINTED STATEMENTS IN REGARD TO WASTE OF FUEL IN POWER PLANTS

In a paper entitled Power-Plant Efficiency, Victor J. Azbe called attention forcibly to the preventable wastes in power plants, especially of the smaller or industrial types, these wastes aggregating about 30 per cent and being due to lack of foresight and business ability, improper design, and improper management and inefficient operation.

Summarized, the author's statements regarding wastes in power plants were:

"Lack of instruments to show whether a plant is operating efficiently is responsible for 10 to 20 per cent or more waste of fuel.

"The greatest and most neglected loss in the average boiler plant is from excess air.

"Economizers are not used more generally because their value is not realized. They are economical in small as well as large plants and the initial investment is usually warranted.

"To save the heat wasted by dirty boilers, pure or properly treated feedwater should be provided. It also saves in cost of cleaning and repairs and increases length of life and safety of the boiler.

"Preheating of furnace air is advocated as capable of easily saving 5 per cent.

"Many power plants that have economical prime movers have auxiliaries that are so uneconomical that the efficiency of the whole plant is greatly reduced.

"For industrial and heating purposes low-pressure steam should be used, reduced through turbines, engines or pumps; in other words, exhaust steam should be used. Using reducing valves to lower steam pressures, while not a waste of heat, is a distinct waste of power.

"About the most wasteful power plants are ice-making and refrigerating plants, often because of low load factor and sometimes from ignorance of proper handling of the machinery.

"Among economical prime movers, uniflow engines, locomobiles and exhaust-steam turbines are specially mentioned, and more general use of superheated steam is urged. Pro-

ducer-gas plants, gas engines and Diesel engines also should find much greater application.

"More economical plants are necessarily more complicated and require better operating men. One-sided development such as inventing more efficient machinery should be balanced by educating the men to properly handle it.

"The greatest efficiency possible in a power plant is a good deal a matter of proper operation and management. Most power plants could make large savings this way, and there are exceptionally few where some improvement could not be made without purchasing new equipment. To obtain full benefit from the equipment on hand the men operating it must be made more efficient.

"Efforts should be made to obtain a government standard engineers' license law all over the United States, and the men should have facilities for getting the education necessary to meet stricter requirements.

"In agitation for smoke prevention it would be quite as much a public duty to save fuel loss as to avoid public nuisance. Many plants are wasting more fuel since operating smokelessly than before, because of using more excess air.

"It is suggested that The American Society of Mechanical Engineers form a Committee for the Prevention of Fuel Losses and General Betterment of Power-Plant Conditions, to devise ways and means whereby the best results could be obtained."

Mr. Azbe's paper drew out a voluminous discussion, not so much in the way of criticism of the author's statements, but more in the nature of general agreement with his views, the discussion resolving itself into the question of how best to put the author's recommendations into effect.

Practically everyone present agreed that power plants were wasteful, but some attributed the waste to the plant owners, some to the engineers and firemen, and others to some other factor. For instance, Joseph Harrington contended that the question of how you are going to improve the operating efficiency of a power plant was not one of apparatus, of equipment or of instruments, or anything of that kind, but was a question absolutely of the human element. Mr. Harrington considered that an incentive has to be supplied for the man at the end of the line; how this is to be done he did not know, but the matter must be adjusted with regard to all the surroundings and is one requiring judgment, tact and perseverance. He thought that something should be done for the compulsory education of the fireman and that a bonus system of some kind would supply the incentive which they now lack.

Strong exception to this contention was taken by Walter N. Polakov, who considered the trouble to be not with the fireman but with the owner or manager of a plant. How can the fireman do good work if he has not a competent leader? If the management or owner does not appreciate the importance of studying the processes involved, if he does not take into consideration the psychology of his employee, if he does not care to make a small investment for approved instruments, you cannot blame the fireman. In other words, if there is to be an educational campaign with the object of protecting our national resources, primarily fuel, the beginning must be made at the banking end, not in the fireroom—at the money end and not with the coal passer.

Edward A. Uehling took a middle course, attributing waste in power plants not altogether to the owners or entirely to the fireman, but partly to the lack of proper instruments. For example, the first instrument usually put in a boiler plant is a draft gage installed in a flue or stack. This is of no use whatever; the only draft gage of any considerable value is a double differential draft gage put on each boiler to give the resistance through the fire as well as that through the boiler.

P. C. Idell thought that one way to make the paper bring results would be to have an appendix giving summaries from different lines of business, showing how preventable waste had been dealt with and the waste overcome.

A. D. Baldwin suggested that the conclusions reached by the author be brought to the attention of the plant owner; he said he had had the pleasure of meeting both the engineer and the owner, and believed that today the engineer is converted without question.

R. J. S. Pigott, Wm. B. Jackson, E. N. Trump, L. C. Roberts, Albert A. Cary, H. R. Cobleigh, F. A. Wardenburg, Professor Estey, Irving E. Moultrop, Sherwood F. Jeter, Wm. F. Schaller, John Hunter, R. B. Clapp, Wm. H. Kavanaugh, A. M. Feldman, Frank L. Strong and D. S. Jacobus continued the discussion of the paper, which centered around specific cases of performance and the deficiencies of power plants which had come within the discussors' experiences.

In a written discussion of Mr. Azbe's paper, W. S. Gould considered that the author had overlooked the most essential point, namely, the character and quantity of the fuel used. It seemed to him useless to discuss the dollars-and-cents losses in any power plant when nothing is known or said regarding the fuel. Coal is too often considered simply as "coal" and assumed to be of some average quality. This is obviously an error. Illinois coal, to which Mr. Azbe evidently confined himself, varies greatly even in the same district and from the same mine. So it is with coal from every district.

At the close of the discussion of his paper, Mr. Azbe made a motion that the Society form a Committee for the Prevention of Fuel Losses and General Betterment of Power-Plant Conditions, to devise ways and means by which the best results could be obtained in power-plant operation. This motion was seconded by Mr. Hunter, who added to it that the committee be requested to publish from time to time the results obtained in the big power plants of the country, so that the membership of the Society might be kept familiar with the progress of the art.

THE ADVANTAGES OF THE IMPACT TUBE AS A MEASURING INSTRUMENT STATED BY MR. MOSS

The next paper presented was a discussion of the fundamental principles, arrangements for actual tests and formulae for impact tubes, by Sanford A. Moss. This discussion enumerated the advantages of the impact tube over the pitot tube, enunciated the law of the impact tube and gave its proof, deduced the impact-tube law for gases, and illustrated typical impact-tube arrangements. It demonstrated the use of the impact tube in calibrating the venturi meter and the orifice, and also for the exploration of irregular jets and for measuring the discharge of high-pressure air by means of an orifice and impact tube, etc.

In a written discussion, Victor R. Gage stated that the work done on blower testing in the Sibley College Laboratories verified some of the conclusions drawn by Mr. Moss in his valuable paper. In this work it was found that the impact tube gave reliable and consistent results, not subject to error from slight misalignment or from stream lines not parallel to the pipe walls. Difficulty had been encountered in obtaining a satisfactory method for determining the pressure head, or the so-called *static* pressure of moving fluids.

John L. Alden also presented a written discussion agreeing in general with the author's conclusions. He stated that the impact-tube law given is merely a restatement of the law of conservation of energy; in other words, the kinetic energy of the jet may be transferred into potential energy in the impact tube with only the immeasurable loss in the tube itself. Such a conclusion should be expected, as the impact tube is primarily an instrument for measuring energy.

The oral discussion of this paper was opened by Mr. Pigott, who gave his own experience with this class of work. Mr. Pigott said:

"One thing that seems noticeable in the nozzle is that for very high velocities the curve should not be too sharp, so as to induce too much of the stream neck to open still further than the nozzle. It is not so much the effect upon the average velocity ultimately, or upon the rate, as the effect upon the impact, making vibrations in the jet similar to those of imperfectly designed steam nozzles. I suppose in most of the work for which these nozzles were used that would hardly occur.

"I am very much inclined to agree with Mr. Moss as to the valuable feature of the single static hole in the pipe rather than the use of the pitot tube. The pitot tube suffers from two very pronounced disadvantages. One is you are never sure that current is flowing past it in the right direction, except you have some device for accelerating the flow, which invariably smooths out the eddies.

"A further disadvantage is that the static openings have not been decided upon definitely. We have had eighteen designs of pitot tubes, but they seem to have simmered down to the type used by Mr. Trump, with pin-holes in the side, the Taylor type being pretty much discarded; but it is quite certain from Mr. Moss's tests and my own, that the static hole in the side of the pipe will give accurate results on pressure, provided it is not in a place to take the sweep in a curve.

"There is one practical feature which can be overcome. Everybody desires to have a section of straight pipe on which to apply the pitot tube or the disk orifice or anything else that is used, even the venturi meter. That is inconvenient to get in many actual installations.

"It occurred to me when we were anxious to test the blowers installed in the 59th Street Station of the Interborough Rapid Transit Co. with forced draft, that a scheme somewhat like the spacer used in egg boxes would be the thing to kill eddies in a pipe, and that proved to be true.

"You can place a pitot tube or impact orifice right up against the exhaust from such a screen, and you cannot find any appreciable difference over the cross-section of the pipe.

"I have used the same scheme in connection with different pitot tubes for measuring steam. The use of such a screen will eliminate the necessity for having a long run of straight pipe up to the measuring device, whatever it may be—they are all sensitive to the same influences, and even the venturi meter feels the influence of eddy currents on the other side. If you use this device, or give it a straight pipe, the venturi meter does give the most consistent results in the measurement of the amount of steam or the measurement of the amount of water used in a plant.

"Next to that for general robustness of reading would come the disk orifice, and last the various forms of pitot tube, and if pains were used to get an absolutely satisfactory form, and pipes were led to the tube, consistent results might be secured. The fault is not in the pitot-tube device, but in the way it is handled.

"The pitot tube suffers from a disadvantage for steam and water measurements. In a pipe line you must deal with small pressure drops, and the pitot tube has the smallest pressure drop of any of these devices, and consequently any leakage is very much more important in the case of a pitot-tube device than in the disk orifice or venturi meter, which deal with larger pressure conditions. If it were not for that, I think the pitot tube, with the static arrangement in the pipe, could compete in most cases with the venturi meter or the disk orifice."

F. J. Richardson asked Mr. Pigott if he had found any difference in the velocity pressures where the velocity was low or high in using the screen, and Mr. Pigott replied he had not.

In reply to a further question of Mr. Richardson, Mr. Pigott said that where he had no room to make a long radius elbow in a pipe to reduce eddies, he avoided the friction drop by putting in a series of fins or turbine blades to direct the flow.

A form of device used on compressed air through a wide range of velocities was described by G. G. Crewson, who had tried out a number of forms of impact tubes. The peculiarity of this device was that the tube extending into the pipe was in the form of a vee, at a small angle, not over 30 deg., facing the flow. With this Mr. Crewson obtained more uniform results over a long range of flow than with any other types he tried. He attributed this to the fact that the tubes set up more or less disturbance in the flow of air themselves, and by making this long vee he could get the point of impact into the undisturbed flow as near as possible.

Wm. H. Kavanaugh gave an example from his own experience of a straightening device to take care of the swirl of water coming out of a standpipe used to water locomotives.

Edgar Buckingham pointed out that the devices mentioned by Mr. Pigott were quite often used in wind tunnels employed for experiments on the aerodynamic properties of aeroplane models. The egg-container device is used in almost all wind tunnels for getting rid of eddies and making the current as nearly straight as possible.

Regarding the turbine-blade device, in the Goettingen wind tunnel, where a fan is employed for pumping air around in a closed circuit, the place is rather small and there is not much space, and consequently they use in the corners turbine blades to save the space.

MR. REYNOLDS GIVES VALUABLE DATA ON THE FLOW OF STEAM AND COMPRESSED AIR

The fifth and last paper of the afternoon was by Herbert B. Reynolds, on The Flow of Air and Steam Through Orifices. The paper was in two parts, the first covering the flow of air through orifices, including a study of pitot and venturi meters for measuring compressed air, and the second the flow of steam through orifices at low pressures.

Mr. Pigott led out the discussion of this paper by extending the thanks of the Research Committee's Sub-Committee on Steam Meters to the author for the data in his paper, all of which he regarded as exceedingly valuable. He said Mr. Reynolds' paper will add to the data as to which is the best measuring device, but it is certain that both the disk orifice and the venturi meter present pronounced advantages over the plain impact tube for ordinary measurements about the power plant.

In connection with the practical use of the devices described, Mr. Pigott said his own experience tended towards the venturi tube, provided serious eddy currents are not allowed to enter into the upstream side of the tube.

The disk orifice has one advantage which may offset, in the majority of cases, its chances of somewhat smaller accuracy. Suppose in installing a plant you provide for the maximum load to be obtained eventually in the steam, or compressed air, or what not, and put in a meter service to measure the flow. If you put in a venturi meter you spend an item of $200 or $300 in a tube for a 10- or 12-in. line, and the readings, after the first few months or a year, are very low and within accurate range of the recording instrument. The disk orifice for this purpose is particularly convenient, in that, in a couple of hours, when the vacuum is down, you can substitute for one size of orifice another size, and have the same recording instrument, and get high accuracy for low loads.

E. D. Thurston asked the author if he had had any experience in using venturi meters in parallel, not necessarily putting two on at a time, but a bank of venturi meters between two headers used in different machines as the demand for air varies. He himself had once used four tubes in a bank and found that with three shut off there was a record on the manometer indicating a slight pressure at the throat.

Frederick N. Connet explained this by saying that if there is a dead end beyond the venturi meter, a dead end at pulsating pressure, there is a constant vibration of the air back and forward from the throat, and a slight differential will be obtained, although there is no flow.

Mr. Connet described some experiments made at Providence in which air was measured in a somewhat simpler way than that described by Mr. Reynolds. The feature of these experiments was a method of measuring the pressure drop through the venturi meter by an electrical method whereby decrements of pressure could be measured with much greater accuracy than could be done by watching a large pressure gage.

A. G. Christie said he had checked the results in Mr. Reynolds' paper against some careful tests made a number of years ago on some Taylor tubes. The coefficient for the Taylor tube placed at the center of a 12-in. pipe was practically 0.8, and as far as he could interpolate from the curves in Mr. Reynolds' paper for a 2-in. pipe, the latter's value was 0.77. The similarity in the value of the two tests on entirely different sizes of pipes struck him as remarkable. In Mr. Rowse's paper in the Transactions of the Society for 1913, the coefficient for an impact tube placed at the center of the pipe, and using a hole on the side of the pipe for the static, was the square root of 80.

Another point in the paper which impressed him was the statement that below a certain number of cubic feet discharge the readings of the pitot tube were unreliable. He checked that over, and estimated that the velocity at which the readings became unreliable was practically 30 ft. per sec. He also checked the same thing in Mr. Rowse's work, and found he was getting results with considerable accuracy as low as 20 ft. per sec.

The question of the swirling effect in a tube was taken up by E. G. Bailey. He said he did not think it was generally appreciated how much this effect amounts to; cases had been found where, in the center of a pipe, at certain velocities the velocity is only 15 per cent of what it would be expected to be with a true elliptical flow, showing the centrifugal force due to the helical motion in the pipe to be enormous. When you get that into the throat of a venturi, there is nothing to stop the helical motion; in fact, its angular velocity is accelerated, giving an impinging force against the opening.

S. A. Moss thought the author had really presented data that showed the venturi meter to be much preferable to the plate orifice, and gave his reasons for arriving at that opinion.

The mathematics of both Mr. Moss's and Mr. Reynolds's papers was discussed by Edgar Buckingham, who said that many who are not familiar with the formulæ given, and similar ones for thermodynamic flow, have a higher opinion of them than is justified. For instance, essential conditions to the validity of Mr. Moss's formula for the velocity of a jet do not exist in practice. In such a formula so many assumptions have to be made that the ideal case to which it applies is far different from most actual cases, and therefore it is not surprising if the formula is not justified by experimental results. The moral is that the engineer, who often despises theoretical work, should not despise the theoretical formula, because he is applying it to a case to which the physicist knows it is not supposed to be applied.

TEXTILE SESSION, WEDNESDAY AFTERNOON

THE Textile Session of the Annual Meeting of the Society was held on Wednesday, December 6, at 2:30 p.m., under the auspices of the Sub-Committee on Textiles, Charles F. Plunkett officiating as Chairman. Three papers were presented at this Session, the first of these being one by Arthur N. Sheldon, entitled Heat Transmission through Various Types of Sash, in which the author gave particulars of experiments made with different types of wood and metal sash, both with single and double glazing, and of others to determine the cause of condensation in double-glazed sash and means for its prevention.

In opening the discussion of the paper, F. J. Hoxie inquired if any experiments had been made where two sash were placed some distance apart, and the space between them heated. Theoretically, he thought that it might be a good idea.

William Dean stated that he had found that one of the difficulties manufacturers experienced was that the holes in the sash let in dirt, which accumulated on the inside and made it almost impossible to clean it without taking out the glass. He believed that most of that dirt came from the inside. If a hole were put in the outside, with the colder air coming in from that side, he thought the condensation on the inside would be materially lessened, if not done away with. In the Bates Manufacturing Company's mill a double-glazed new sash was used, with ventilating sections in the sawtooth, which could be opened at times, and he believed when they got the colder air inside that it lessened the condensation more or less on the interior surface, which would bear out the result of Mr. Sheldon's test, that an outside opening would be preferable to an inside; but that presented the problem then of keeping the dirt and dust and water out, keeping it from getting into the air space, which no doubt could be worked out.

Charles H. Bigelow inquired to what extent double glazing was being used in factories, and also how much condensation there would be on the inside of a concrete roof, which was also likely to cause trouble, and what steps could be taken to prevent it at a reasonable cost.

In reply the author said that double glazing was used to quite an extent, not to so great an extent with steel as with wood, on account of the additional cost of double glazing

steel sash; and that additional cost, as described in the paper, sometimes worked out to a disadvantage, and it did not pay to do it. No doubt there would be a saving on wood in this locality of about 32 per cent, and there was no question about that being a paying investment. As regarded protecting the concrete roof, hair or cork insulation could be applied to reduce the heat loss.

William W. Crosby recalled particulars of a building of considerable size where steel sash were double glazed with about ¼ in. of space between, and only about two-thirds of the usual amount of radiation was supplied, and only about one-half of the usual amount was in use on the coldest days. The building had a very cold exposure.

W. R. Cobb[1] stated that his firm had probably done more double glazing than any other in the country, and for twenty-three years had done more or less experimenting along that line. There was no doubt a great saving in coal by the use of double glazing. The principal objection to it was the accumulation of dirt between the two layers of glass, and if he were building a factory, he would want the double sash at least, so that one could get at all sides of the glass to clean it. His firm built hotbeds with double-glazed sash, and in the coldest weather they required no mats or shutters.

R. W. Weed desired the author to state his experience in comparing a double-glazed steel sash with a double sash. He had found that the great heat loss was due not to conduction through the glass, but to leakage around the cracks, etc., and that the heat losses would run around 80 per cent, whereas that due to conduction would be only about 15 per cent. For that reason he believed that the double sash was preferable to double-glazing sash, because it furnished a double insulation.

In reply the author stated that there was no doubt that two windows, a storm window outside of the regular window, would prove more beneficial as far as heat losses went than double glazing; but the double glazing was less expensive. In Canada they triple-glazed, with three lights, in refrigerating plants, etc.

D. Seabury stated that the double sash had an advantage where it was desired to put prism glass on the outside, as it gave a chance to keep it clean.

The author, in reply to a question by the Chairman, stated that the tests on heat transmission were made before the holes were put in the lights of glass. Later, they bored the different lights of glass with these holes, and then experimented further with regard to condensation, regardless of heat transmission. The holes were only about the size of a lead pencil, and placed near the bottom, so there could have been but very little heat loss through them.

A NOVEL METHOD OF STUDYING SPONTANEOUS IGNITION DESCRIBED BY MR. HOXIE

The second paper to be read was one by Frederick J. Hoxie, entitled Spontaneous Ignition Studied by Means of Photographic Plates, in which the author stated that various substances undergoing slow oxidation gave off hydrogen peroxide, which latter was capable of making a developable image on a photographic plate, the intensity of the image being roughly proportional to the rate of absorption.

Opening the discussion, Ira H. Woolson asked the author if he had discovered any difference in the activity of charcoal due to the variety of woods from which it was made; whether wood that contained resin, for instance, had any different activity upon the plate, as compared with the wood that did not contain resin.

The author, in reply, stated that he had found certain varieties of wood were more active than others, but that some other specimens of the same variety were not active, so that he was not inclined to generalize very strongly on that point.

C. P. Beistle[1] stated that charcoal made from beech, birch or maple was more liable to spontaneous ignition than that made from other woods. He thought the real cause of the risk in charcoal was due to the process rather than to the wood used. Most charcoal nowadays was made as a by-product of making wood alcohol and acetate of lime, and almost invariably retained a good deal of volatile matter. Formerly, charcoal was burned anywhere from seven to fourteen days, and was very hard and very dense, and almost free from spontaneous heating.

Leonard Waldo stated that he had had a case come up of an ignition of flash powders, and was very much bothered to find some simple way by which the rate of oxidation of magnesia, for instance, could be determined, so that it could be known what was taking place. He desired to learn whether oxidation of powdered metals, either with or without the presence of an oxidizing substance, would be shown by the author's orthonon plates, by simply putting the metal in contact with the plates and letting it stay there awhile exposed to the air; also whether there were any publications that gave extended lists of temperatures of ignition. If the gradual oxidation of metal could be shown, either in steels or lighter metals, by simply putting them on a sensitized plate, and developing the plate later, this would be a most important contribution to the technique of oxidation.

The author, in replying, said that he had never heard of any experiments being made on magnesium, but knew of no reason why they should not be made. In regard to the ignition points of different substances, there was quite a lot of information available. To say, for example, that the ignition point of wood was 500 deg. did not mean anything, for the reason that that particular wood had been exposed to light, whereas if it had been strongly charred, the point might have been changed materially.

Christopher H. Bierbaum desired to learn whether the photographs had been made by placing the substances in close proximity to the plate, or whether lenses were used, and also what plates. One question raised was whether the oxidation actually was in direct proportion to the actinic effect upon the plate. The chemistry of it was that we started with bromide of silver on the plate. The bromine, being a strong oxidizer, produced that salt in the presence of the actinic ray, so that it would readily change from a bromide to an oxide. That was done during the development. Was it not possible that it was all entirely due to the ionic potential of the substance? The question was whether it was actually due to actinic rays or vibrations in the hypothetic ether, or to the presence of ionic emanations, or a chemical change.

The author replied that the action was purely a chemical one. Apparently most any rapid plate could be used, but a slow plate could not be used successfully. Some exposures had been made on Lumière X-ray plates, a very rapid plate, and some were made on the standard orthonon, also a rapid plate, but in no sense were they photographs. The first impression was that this was a radio-active phenomenon, that it was an emanation from some substance, very much like the X-ray, but this had been found to be incorrect. One experi-

[1] With Lord & Burnham Co., 30 E. 42d St., New York.

[1] With Bureau of Explosives, American Railway Association, 75 Church Street, New York.

ment tried was to take a glass and put it over the object which was giving off the emanations, but there was nothing to indicate that there was really a substance coming off. If that had been a remarkably short wave of light, it could possibly have had a similar effect. He thought the active agent present was hydrogen dioxide. It was well known that hydrogen dioxide, when put in contact with a photographic plate, would make a developable image. The active agent might possibly be some other form of active oxygen, but ozone, without the presence of water, did not give this action.

Mr. Bierbaum thought that in the experiment made with the covered glass, if the author had taken a cover glass made of quartz crystal, and found that in one case he had the effect and in the other case he did not, he would prove it due to short waves, because the extremely short actinic waves would pass through quartz and produce actinic effects which were not possible through glass at all. He thought the author's experiments on this point were very interesting, because they seemed to indicate that the presence of ionic emanations produced the same effect as the short actinic wave.

The Chairman said that, in the interest of the cotton manufacturers, he would like to ask the author whether he had discovered that there was a material change in cotton fiber by the slow oxidation mentioned in the paper, which it was said is going on at all times, sometimes being on the outside of the bale, and having a moisture and temperature differing from that in the interior of the bale. And whether it had been found true that after a long time the staple was weakened on account of the oxidation which had been going on, possibly for years, before the bale had been opened for use.

The author, replying, said there was little doubt but what the strength of the staple had suffered. A common sight in almost any cotton mill, where pieces of sheeting were used for window curtains, was that where the moisture touched a curtain it turned brown, and had every appearance of being as thoroughly burned as if it had been in contact with hot iron; this was doubtless due to the oxidation which had taken place because of the combination of moisture and light. He had often found cotton and linen, linen particularly, which had been subjected to a comparatively low temperature, after a good period of years, that had every appearance of being as thoroughly charred as though it had been in contact with a hot stove. Doubtless that was due to the amount of moisture it contained. Mr. Hartshorn, in his classical work on moisture in cotton, mentioned the fact that cotton which had been submitted to changes of moisture and dryness for a considerable length of time seemed to lose its property of absorbing moisture, and of following the law which he had shown to exist for other cotton. Last year Prof. Naumberg, of the Institute of Technology, had made some further experiments along that line, in which he collected some old cotton that had been exposed to the air for a long time, and found that it reached an equilibrium to the atmospheric moisture at quite a few per cent less. Apparently, this was not a question of fungus growth, but was purely a question of the chemistry of cotton.

The Chairman remarked that cotton eighteen or twenty years old was now coming on the market because of the present high price. The question was whether there had been a very serious deterioration in the interior portions of the bale, by reason of combustion that had been going on slowly, but over a long period of years; whether it was really deteriorated so that it would be unfit for use, or suitable for the uses for which such cotton would be apt to be used. He also desired information as to cotton fabric piled in storehouses in bales. Many times discoloration was found on the part toward the windows. Was it true that there would be a deterioration of the strength of that fabric, and would the color indicate that the fabric itself had been injured by its storage, where it had received the rays of light?

The author, as to the first question, was inclined to believe that the staple would be found to be weaker, and, under certain conditions, considerably so. He thought that if the discolored cotton were boiled in caustic it would become as white as ever, but there would be less cotton, and that the process could be repeated until there was not much cotton left. Doubtless the action had something to do with the temperature. If the storehouse were kept at a very low temperature, it would no doubt reduce the action, but to what extent he did not know.

Replying to inquiries as to how the substances were exposed, he said that in the case of articles of wood they were placed in direct contact with the plate, but the oils were kept a little distance away, to avoid getting oil spots on the plate. The nearer the object to the plate the stronger the action was, and therefore it was desirable to get it as close as possible.

In regard to the photograph with a part marked "screened from sunlight," he would say that he took a piece of wood into a semi-dark room, so that the amount of actinic light was negative, and planed off the surface which had already been acted on by light. He then placed on it a piece of tinfoil which had a square hole cut in the center, and then placed it in the sunlight. Where the tinfoil was the sunlight did not strike the wood. He then took this into the dark room and removed the tinfoil and exposed the wood to the sensitive surface of the plate, and then developed the plate. The part of the wood which had been screened from the sunlight had practically no action on the plate, showing that it was a peculiarity of the wood which had been acted upon by sunlight.

Mr. Bierbaum stated that if the author had proceeded to expose part of a diamond to daylight, and then produced the same thing—he understood the diamond would have the same effect — the part exposed to sunlight would have a similar effect, that is, its actinic effect on the photographic plate would be the same. In that case there would be no chemical change, it would be purely an emanation.

MR. PERKINS DISCUSSES METHODS OF ELIMINATING VIBRATION IN TEXTILE-MILL BUILDINGS

The final paper of the Session was then presented by G. H. Perkins, its title being Vibration in Textile-Mill Buildings. After stating the nature of vibration in textile-mill floors, the author dealt successively with the causes of such vibration, the objectionable effects it produced, means for its elimination, and precautions to be observed when textile machines are mounted on rigid floors.

Charles H. Bigelow, in opening the discussion, recalled one building, erected about nineteen years ago on piles, that swayed back and forth in time with two 1200-kw. engines, 75 times a minute, so much so that the window weights could be heard to rattle back and forth in their casings. The actual movement of the corner of the building in relation to a pile of lumber 50 ft. away on a marsh was $\frac{3}{8}$ in. When the two engines were running, the motion would come to be a maximum, and then would cease as the engines opposed each other. In another building he had found a 4200-hp. engine, under which the whole foundation moved around about $\frac{1}{2}$ in.; this was stopped by anchoring the foundation to other parts

of the building. It was certainly a serious matter. How much actual power was lost in the machinery he could not say.

W. W. Crosby asked that further information be given by the author as to the curves shown in the paper, and that the plane of vibration be defined. He also desired to know whether the looms were driven by motor or by belt. He would say that he knew of a certain concern which had several foreign mills, built of rigid construction, with steel beams and brick arches, and they had hesitated about building a new mill with heavy beams and plank, as we did our slow-burning construction, because they thought it would be so full of vibration that the machinery would not last. After several years' operation, he had been told that as yet no undue wearing of parts had been detected which might be ascribed to vibration.

Henry A. Hale, Jr., stated that it had been found that the accidents to employees in spinning and weaving operations were largely due to carelessness. He thought nothing engendered carelessness more than fatigue, and if by eliminating vibration this could be cut down, and thereby the number of accidents, it appeared to him that the resulting economy was something that could not be overlooked. Additionally, the effect of vibration on operators was to slow them up in their work.

Ira H. Woolson inquired of the author whether vibration was a matter of common complaint with the operators—whether it was physically objectionable to them.

W. W. Crosby stated that he had heard of employees making serious objections to working on floors which were too rigid. Help that had been working on wooden floors had raised all sorts of objections because they had been put to work on concrete floors.

The Chairman stated that he had learned from the author of one mill where they still had, after fifty years, some wooden frame looms, and those looms were heaving in all sorts of ways every time the lathe moved, and still the treasurer of that mill said he was getting the best cloth from those looms, better than from the modern heavy looms, and that one could see the loom heave at all times, with every oscillation of the lathe. The Pemberton mill, in Lawrence, which collapsed completely in 1863 or 1864, was a very rigid building and only three years old, and it collapsed completely; and it was a question whether any building had been known to collapse from vibration. It was a rather interesting point, and the building apparently must have been well constructed to have shown as much rigidity as it did on all the floor surfaces in the mill. There were peculiarities arising from this question which made it an exceedingly interesting one. It was particularly important to the cotton and other textile industries to know whether to be alarmed by the oscillation that they found in their mills, or to know if their mills were too rigid that they might collapse, or that they might not get any better results, even psychologically.

In a written discussion, Maurice Deutsch[1] stated that it was often asked why English mills made such good yarn out of poorer cotton than used in America. The answer to this, he thought, lay in more rigid construction of the mills and the special attention given to the cushioning and arrangement of machinery. In a sawtooth weave shed in England, he knew of looms standing on flagstones and running at 220 to 225 picks per min. Just how rigid a structure should be, would depend upon the material fabricated and other conditions, but for textile mills he thought rigidity of structure should be sought for, and the detrimental effect of vibrations minimized by the proper application of composite absorption material between the machines and the structure.

It had been found that vibrations having a frequency of about 15 per sec. and a double amplitude of about 0.002 in. had generally been the cause for complaints made by occupants of houses in the vicinity of railway trains or certain types of machinery, also that a frequency of about 7 per sec. and a double amplitude of 0.0012 to 0.0016 in. could just be felt.

The important question of the human susceptibility to vibration was one to which little study had been given in this country. In England, however, some very interesting observations had been made by Mr. Digby and Capt. H. R. Sankey.

How far beyond the limit of perceptibility the vibrations recorded by the author were, might be somewhat appreciated when compared to the observations of Prof. E. E. Hall, of Berkeley, Cal., that when the frequency was 2 per sec. the double amplitude had to be approximately 0.004 in. before it could be felt. From many observations made in buildings the discussor had found that amplitudes as low as 0.002 in. when the frequency was over 10 per sec., were a genuine source of annoyance to occupants. It had been found that vertical vibrations damped out much more rapidly than did horizontal. The latter were more apt to produce detrimental effects to the structure, while the former might produce the greater effect on the machines and fabric.

Morton C. Tuttle,[1] in a written communication, gave numerous interesting and instructive particulars of experiences brought out in the course of the investigation of the effects of vibration now being conducted by the Aberthaw Construction Company. So far as the investigation dealt with textile mills, it seemed to show that vibration tended to increase the power requirements of machinery and to limit the speed of operation and hence the output. There was a certain diversity of opinion among the correspondents reporting, but this, it appeared, depended upon the type and character of building. It was made quite evident, however, that the most serious cases of vibration were found in old buildings or those unsuited for use as textile mills.

The author, in closing the discussion, replied to Mr. Crosby's queries, stating that the records given in the paper showed longitudinal vibration only. He gave particulars regarding the type of drive used for the various banks of looms, and called attention to the record taken at Station 1—about 50 ft. from a group of electrically driven looms, which showed that the vibration was transmitted undiminished in amplitude through the floor.

As to the question asked by Mr. Woolson, in all cases that had come to his attention, new help generally found vibration quite objectionable, but after a time they became accustomed to it. There were certain mills to which he went occasionally where he would not care to work himself for any length of time, and he felt a certain apprehension just in passing through them.

If he had understood the discussion of Mr. Deutsch correctly, that gentleman had indicated that if we should decrease the amplitude by making a more rigid building, it would be possible to increase the frequency; but he thought if Mr. Deutsch attempted to run 104-in. looms at more than 100 picks per min., he would be in trouble, no matter what sort of building he was in. It did not mean that these looms could be run up to 200 simply by installing them in a rigid building, such as they had in England.

[1] Civil Engineer, 50 Church Street, New York.

[1] Secretary, Aberthaw Construction Company, Boston, Mass.

TOPICAL DISCUSSION ON MANAGEMENT

IT is the custom of the Society occasionally to hold meetings without regularly prepared papers, for topical discussion and the interchange of experiences. Such a session was arranged by the Committee on Meetings for Wednesday afternoon of the Annual Meeting, on Recent Developments in Industrial Management. There were three other sessions in progress at the same time, and it was necessary to assign to this session the small meeting hall on the twelfth floor of the building, seating less than one hundred. By actual count there were one hundred and twenty-five present throughout the afternoon, with a total attendance of perhaps two hundred, and much of the time there was not even standing room,—this in evidence of the very general interest in the subject of management.

COÖPERATION OF WORKMEN, BY E. E. BARNEY

The first discussion was by E. E. Barney, of the Remington Typewriter Company, on How to Secure the Coöperation of Workmen. He said that coöperation must mean more than "working together"; it must mean working together with common interest toward a common end which, when attained, should be mutually beneficial. In analyzing his subject he made a unique comparison of the laws of physical science with those of human nature, referring to the following phenomena and properties of matter: Density, specific gravity, heat, light, magnetism, and electricity.

For example, he said that *density* in physics referred to the mass of a body. Among mankind we also had density,—the mass,—the untrained, unskilled, the hopeful and the discouraged; a mass welded together, but alive and struggling, like a bar under tension.

Heat, he said, was positive; it caused most substances to expand. "Let us try the effect of heat or warmth on our associates, the workmen. Warm them with human interest. . . . Men are susceptible to sincerity, but often are slow in absorbing the warmth of sincerity. Like the metal which expands when plunged into the fire, they often shrink and resist the glow and warmth for fear of the motive which may lie hidden behind it."

Magnetism was a force easily likened to the qualities necessary in coöperation. One could not expect a workman to lead in the spirit of coöperation—he had not been trained that way. Too often the magnet of plausible argument which at first attracted him proved a repellant force when the real motive of selfishness became exposed.

Electricity was a subtle power which demanded control. It was the central conscious or unconscious thought which affected our acts toward those whom we would control or influence. In the development of organizations, cables were led from the central power to points where the power was needed. With ideas and ideals as the central power it was possible through proper mediums to convey these great distances; but make one break in the direct line, i.e., let one man of the direct organization fail to transmit the current of standards sent out from the head, and we would fail in delivering beyond that point the vital fluid on which depended the success of our hopes.

In conclusion, the speaker contended that to secure the coöperation of the workmen one must, as in the old colored woman's receipt for rabbit pie, "first cotch your rabbit,"—the mass,—the men. One must select the individual and classify him according to his ability; warm him with the interest he deserves; enlighten and train him to the advantage of both; attract him by fairness and consideration; and make sure that one's organization was carrying the proper message of the spirit of coöperation to and beyond the workmen, who were the most valued asset of any industry.

THE VALUE OF HUMAN RELATIONSHIPS IN INDUSTRY

In discussion of Mr. Barney's remarks, R. B. Wolf said that in scientific management one must study the forces which had been outlined, scientifically. When dealing with men and attempting to direct them in these operations, we were dealing with something in which the realm of facts found in natural law did not exist; in other words, man was a free agent. In dealing with material things there was a realm of facts which conformed absolutely to law, as in the conversion of water to ice at thirty-two degrees. We knew that such things always happened in that particular way. There were, however, many ways by which water could be reduced to a temperature of thirty-two degrees, as by carbonic acid gas, or by moving it northward to a colder climate. To obtain such change in conditions the will of a human being was essential. Man was the instrument for creating the conditions through which the natural law could operate, and must be reckoned with in that aspect and given more freedom and liberty for the exercise of his creative faculties.

W. S. Rogers, who said that for "twenty-eight years he had been a member of our venerable Society," but nevertheless was the "youngest one present," spoke at length in a reminiscent and anecdotal vein. Throughout he emphasized the importance of the *man* as an asset in organization, and gave many illustrations from his own experience to show that success and contentment for all concerned had come from a consideration of the human factor.

Thirty years ago his friend and preceptor, John E. Sweet, had built a special machine which the speaker went to see, and after inspection remarked, "It is a success." "No," said Uncle John, "I have made a big mistake. I should have built a man first."

Mr. Rogers related how in 1896 he went to Cincinnati on a two years' contract to take charge of an "old scrap pile of a plant" which was losing money. At the end of the contract they were making twenty per cent dividends, and the owners complimented him highly for the things developed by a mechanical engineer. As a matter of fact, he "had not used any mechanical brains whatever." He had simply studied and experimented with the men. He had not added a single new machine nor made a single new jig. Neither had a man been discharged nor a man added to the payroll.

Twelve years ago he had the desire of his life in a plant where he did not have to ask a man on the board of directors what he should do. The cash capital "was $14.95 and they could not borrow a cent." Today the plant was a great success and its stock was selling for "six times its original par value."

This was accomplished through coöperation with the men to make them feel that they were a part of the organization. Houses were put up, which they were assisted in buying. Profit sharing was introduced, and payments were made monthly, a plan he had learned in England. A shop legislature was introduced, with a House which met in the superin-

tendent's office and a Senate in the manager's office. In case of necessity they met jointly. No man could be discharged without bringing the case to the House, and if possible another place would be found for him in the works.

A special training school for employees was started. Charts were introduced in the House for showing the output of production. Once a month there was a meeting of the entire force, at which the different men or departments were shown where money was lost; and how such loss took money out of the other partners' pockets and how it might be rectified.

The trend of Mr. Rogers' remarks was that no matter how fine the buildings, how modern the machinery, nor how refined the system, all were worthless unless the man was considered of the highest importance and brought into the closest possible union with his employer. Buildings, machines and systems could always be replaced; but good labor must be evolved, and once destroyed takes years to replace.

GRAPHICAL CONTROL ON THE EXCEPTION PRINCIPLE. BY FRANK B. GILBRETH

In introducing the subject of the use of graphical charts in industrial establishments, Frank B. Gilbreth outlined the possibilities of eliminating waste through the use of the exception principle in management. No cost system, nor chart system, can be considered really satisfactory unless it fulfils the following requirements; i.e., it must determine and show:

1 What the quantities of individual outputs should be (prophecies of outputs).
2 Prompt records of individual outputs.
3 What the costs should be (prophecies of costs).
4 Prompt records of costs.
5 Causes of fluctuations and deviations of outputs and costs from prophesied outputs and costs.

It was obvious that the foreman, or other functionary, should see promptly all the records of output in his particular department. The time of the over-foreman, however, who might have several departments under him, was too valuable to attempt to examine all the records of all the men, and he should be supplied with information in concise form, such as was often furnished by "averages."

While ordinary averages had their use, their value was slight compared with the benefits which might result from concentrating the same attention on those individual cases which brought the average away from the ideal.

From causes marked on the chart it might be found that the worker's slow output was due to the lack of proper tools; to the routing system having failed to give him proper materials in the right quantities, in the right sequence, at the right time; or to the man's not having been properly instructed; to there having been an unwise selection of the man or the machine, or both, for the particular job, etc.

The worker, also, would be more careful not to do anything which was not expected of him, because he would know that the exception would surely be noticed by those higher up and would interfere with his chances for promotion or transfer to work of a more desirable kind. Knowledge that they might be investigated would create a tendency on the part of the foreman and the workers to coöperate with others whose work affected theirs, or who in turn might be investigated.

These charts, with the "exclusion zones," enabled the executive to eliminate the motions required for general oversight and inspection until a place on a chart was brought automatically to his attention where he could actually help those below him and furnish them with better instructions for handling their work more efficiently; or for making such changes as would naturally result in promotion, or the selecting or shifting of individuals better fitted to do work elsewhere. The possibilities of relieving the executive of unnecessary motions and of enabling him to be more efficient in his own work were not exceeded in the case of any manual worker.

STANDARDIZATION IN INDUSTRIAL MANAGEMENT. BY SANFORD E. THOMPSON

In introducing the subject of standardization, Sanford E. Thompson said that whereas apparatus and objects used in manufacturing had been extensively standardized, machinery had been improved, plant layout perfected, and in many cases the personnel of the managing force carefully selected, the standardization of the processes of manufacture were as yet almost ridiculously crude. We found laborers selecting their own shovels regardless of the class of earth, or the adaptability of a long or short handle, and we saw them using shovels in whatever way they saw fit. Workmen were not only allowed to select their tools, but allowed to utilize their material and to do the job in any way they chose. It could not even be said that they used their "initiative"; they simply followed in a rut, often a very deep one, worn out by their predecessors on the particular job in the particular shop.

Those who had given thorough consideration to modern industrial methods appreciated that there was one best way to do each job and that every operative ought to handle every piece of work by this standard method. Some might not agree with this, perhaps, because they emphasized too strongly the difference in make-up of different operatives; but the tendency was towards standardization. Not until we arrived at standards in methods of performing individual operations, as well as standards for the layout and general handling of the work, could we hope to have a properly managed plant.

Referring to stop-watches as an element in the study of methods, the speaker said that while they were a necessity for standardization, if they were used simply to find the time in which an operation was being performed, instead of the time in which it ought to be performed, they were comparatively useless. It was the getting at the proper methods and determining the proper tools and machinery by scientific study that meant real saving in time and material.

For example, in piece work where a level rate was maintained employees were all following the slowest and poorest man, and the management was helpless because it did not know the best or the quickest way. By giving definite instructions in all classes of work, just as was being done in many cases of machine-shop work, it was possible for the majority of the men to learn instead to work at the speed and by the methods adopted by the most highly skilled.

In certain kinds of work, standardization might be practically the whole thing. It was amazing how standardization simplified certain processes which had been considered so variable as to make it impossible to produce uniform results. A good example of this was in the cooking of sulphite pulp. The wood came to the digesters, which were large steel tanks, perhaps 12 ft. in diameter by 30 ft. high, where it was cooked under high pressure in bisulphite of lime liquor. Formerly it was the universal belief of all pulp manufacturers that on account of variations in moisture, differences in quality of wood, variations in the character of the acid, and many other variables, the largest of which was designated as "pure cussedness," uniform

length of time for cooking and a uniform product were impossible to obtain. Cooking, in other words, was an occult process known only by a few experienced men, and even with those experienced men operating the digesters, variables were impossible to allow for. Now, as a result of standardization which involved the manufacture of bisulphite liquor as well as the cooking process itself, it had been found possible to produce pulp from ordinary wood coming from various sources, which from the paper-mill standpoint was practically uniform in quality, and to bring off the cooks at lengths which varied by not over five or ten minutes.

The standardizing in the digester house consisted essentially in determining the curves of pressure and temperature which should be followed during the process of cooking, giving these definite standards to the men handling the digesters and requiring them to follow the standards set. In order to obtain the most uniform results, however, it was found advisable, and very effective, to make definite records of just how much each cook varied from the given curve and give a bonus for maintaining the curve. Similar plans had been found very effective in other classes of work, illustrating very clearly how useful was the form of bonus payment for maintaining quality at a high standard as well as in other cases of maintaining standards of output.

A SPLENDID EXAMPLE OF COÖPERATIVE AND SERVICE WORK FOR EMPLOYEES

A. J. Baker, who was in attendance at the Annual Meeting as representative of the Cincinati Section, quite won his audience by the pleasing account which he gave of the Employee's Service Work of the Cincinnati Milling Machine Co. He said that he had conferred with a friend about the relationship between manager and employee, who remarked that he believed the main function of the people who adjusted this relationship was to arrange so that the employee could take home twice as much money as he did before; and in thinking it over he admitted that it came the nearest of anything to summarizing the whole result that it was desired to attain. If the amount in the pay envelope were doubled, everybody was happy; but if substantial progress were not made in this direction, no matter what the system, nothing would really have been accomplished.

At his plant the combination of the premium and bonus systems was used, although he believed their characteristics were so obscured that the founders of these, Mr. Halsey and Mr. Taylor, would disown them.

With this arrangement there was an inducement for high-grade men who did not content themselves with just reaching the standard time set, as well as for the standard man who just measured up to the time-study limit; and for the man who had secured his job under false pretenses and who was not worth the money he was being paid, there was an inducement to work up to the point where he *was* worth the money. As a result it has been possible to hold the organization together in a very satisfactory way during the period of labor trouble that has been expensive for Cincinnati manufacturers. That, he said, was the starting point of the special relations that had been established.

In the study of men and conditions, it was decided that the physical condition of the employee became a most important element, and a physician was hired and established with headquarters, who at once assumed the position of intermediary between the officers of the firm and the men in the shop. It was aimed as far as possible to return somewhat to the old feelings and close relations that used to exist between employer and employee, but which it had often seemed impossible to maintain under present industrial conditions.

It used to be that the apprentice was a member of his employer's family and the relationships were, of course, satisfactory. At the other extreme was the paternalism now practiced by some of our large organizations which, Mr. Baker felt, was not entirely in keeping with the institutions of this country, particularly if it extended to the time outside of office hours. His firm limited itself to investigation of the man during shop time, and, since it was difficult for the president, vice-president and other officials to attend to their business duties and also to act as the intermediary who would bring about the important personal relations which were desired, this trust was given to the physician, who, by virtue of his office and the character of his work, would be a very suitable and satisfactory man for the purpose.

It had proved that as many as 250 cases were sometimes treated in a day in a plant employing only 1600 men. They did not come necessarily because of serious illness or injury, but often because of minor things with respect to themselves or members of their families. The physician was thus close to the men and was often consulted on matters not related to personal health.

Among the matters investigated was the question of food. Oakley, the suburb where the works are located, had inadequate lunch facilities, and the men who did not live in the vicinity either brought a lunch with them, which they ate cold, or else went out to a saloon. After analyzing the situation it was decided to purchase a complete set of utensils, refrigerators, counters, etc., which were turned over to the employees, who were told to use the equipment for operating their own lunch room. They appointed a committee to purchase their own food and set their own prices; in short, they had a representative organization with which the management was not connected in any way, and it was extraordinarily successful. Starting with a patronage of 60 or 70 a day, there were now about 450 who secured their lunches there.

Here again the physician came in, for he was able to suggest to the men the dietetic value of certain foods and to assist them not only in securing good nourishment but in reducing the cost. By this means the health of the employees undoubtedly had been helped. A mutual-aid association was also started which the firm was supporting financially, but which was run by the employees and to which they contributed through a special fund for sickness benefits. Here again the physician, having the confidence of the men, was in many cases able to forestall serious illness.

It was surprising how many of the men were found to have incipient diseases unknown to them, which the physician discovered and was able to treat successfully because of their early discovery. Further, he could very frequently state to the superintendent that a certain man was not physically fitted for the kind of work he was doing, which would lead to his being transferred to a department adapted to his condition, thus saving the money lost in breaking in a new man, and winning the gratitude of the one who was transferred. No man was discharged without having the medical department look into the situation, and it must also be with the consent of the superintendent. As a result of the careful investigation it was often possible to find the cause of the failing and to put the man in some other department where his peculiar make-up would not conflict with that of the foreman of the department.

Referring to a remark by Mr. Rogers to the effect that one should "study to make them believe they are a part of us," he said it was an ideal expression of what the firm was trying to

do. While his own statement at the outset as to the financial end was a little more cold-blooded, in the end they were trying to make the men believe they were a part of them, and not only believe, but that they actually were a part of them. That was the whole thing. In order to encourage this attitude, records were kept. The speaker outlined a plan for paying a monthly or quarterly bonus, according to the average output of production per man, in addition to the extra earnings which a man would receive from his own individual increased production.

Mr. Baker further referred to the labor situation in Cincinnati more than a year ago, when a strike was declared in many of the plants in the downtown section of the city and where in the different plants the strike was more or less successful. Later, the attempt was made at Oakley and not over 30 or 40 men responded, and within a short time there were more men working than ever before. Without any suggestion or assistance from the management the responsible men in the shop got together and went over the whole situation and decided that it would be for their interest to combat the strike. An anti-strike committee was formed, which was most influential in averting the threatened labor troubles. Thus the men with whom these better relationships had been established fought for the firm when the occasion arose.

AN APPEAL FOR THE DURABLE SATISFACTIONS IN LIFE FOR WORKMEN AS WELL AS EMPLOYER

Richard A. Feiss, who came into the meeting as Mr. Baker was speaking about personal relationships in his organization, testified to the excellent spirit which he knew existed there, and which he said was as fine as in any plant in the country but one, and that one was his own.

While democracy was one of his hobbies, he felt that the durable satisfactions in life did not necessarily come as a result of any one scheme of organization or system. The tendency among business men and engineers was to think that when they had a good thing it was the only thing in the world. That was not true. If one analyzed Rogers' profit-sharing plan, or Gantt's method of paying bonuses, or Thompson's method of paying premiums, they would be found simply to be different methods for accomplishing the same thing, and their success would depend upon how they were worked out and what was the spirit back of them. In his own plant they were using a type of piece-rate system, by which he was sure that all of his 800 employees were as much partners as were Mr. Rogers.' The employees themselves did not pass upon the hiring of others, because he and they did not think they were competent to do so. An expert was employed to study the question and to pass upon them. He believed democracy which was subject to expert rule was the coming democracy and the one which America would have to adopt in order to become efficient.

He said that people work for two things: they work for money and they work for other satisfactions, such as contentment. If one thought they worked for money alone, let him try to get away his own employees; and if one thought they worked for the other thing, he might try to hire them without paying them.

The dollars-and-cents proposition must be looked after at first so that the workmen may procure those things which mean home and a decent standard of living,—and even a higher standard of living, because a man who stagnates is like a flower which grows no longer but fades, withers and dies. It must be realized that everybody, whether customer, worker or boss, must make progress and have an ever-increasing share of the things of the world; and then the important principles must be realized that the greater fruits of industry are only procurable by greater productivity and that greater productivity is only obtainable by mutual coöperation.

EFFICIENCY FOR THE MAN HIGHER UP

H. L. Gantt said that a lot of people had been talking efficiency and getting up fine charts, and when asked what they did with them they would say that they did nothing. We were all making charts to show how efficient the workman was, but very few were making charts to show how efficient the management was. There might be workmen doing something that did not need to be done at all, and doing it very efficiently. Until our efficiency system reached up to the executive and we could measure the efficiency of our executives with the same degree of accuracy that we now thought we were measuring the efficiency of the employees, it would not amount to very much.

Mr. Gantt referred to the Valuation Session to be held the next day and said that most of the valuation by accountants and financiers gave the valuation of bricks and mortar and machinery; but he had noticed in Mr. Polakov's paper to be presented, on Valuation of Industrial Properties vs. Valuation of Industrial Methods, that the value of machinery was not in the machinery itself but *in how it was used*,—in other words, in the human element behind it. Mr. Rogers had told about the little old plant that had gone to pieces and when he took it was not paying expenses; but by putting men and brains into it he got something out of it. How would public accountants have valued that plant before Mr. Rogers went there, and afterwards? They did not know how to do it and engineers must tell them how. Until we could measure and value the human element we would not be able to get anywhere in this work.

GENERAL DISCUSSION

By way of comment on the different systems of paying wages—premium, bonus, piece work, etc., W. S. Rogers raised the question of what was the distinction between a bonus and a tip. Were we tipping our men to do good work? At his plant the men were not paid on this basis for doing good work. They were partners. Every month they went to the bulletin board and read the comparison of sales as well as the comparison of their day's or month's work with the previous day or month. In response to an inquiry as to what he did in hard times, when he might have to lay off help, Mr. Rogers explained that this had not been necessary. His product was staple and in times of business depression he had manufactured for stock.

W. O. Platt offered himself as "a horrible example of the man who does not use charts." He employed 400 men and did not even have a time clock. To a person who had built up a small business the question would come up of how big a place one must have in order to put in, for example, Mr. Gilbreth's charts. He might be told that he was losing a certain percentage in efficiency by having no bonus system; another percentage by not using stop watches, nor experts to analyze the motions of his men; and another percentage by having no time clocks. While he said he must admit that he was older than some who were present, and perhaps less active, he had found that every one of the devices or expedients mentioned took time and energy, and that unless this fact was considered the system would get top-heavy.

The point was made by A. R. Burnett that graphic charts such as had been mentioned as being prepared for the informa-

tion of the operatives should be used also to bring the executive closer to the details of the work. In reply, R. B. Wolf explained that he was using such charts to show the men what they were accomplishing and what was the progress of their work. This gave them the factor of interest and joy in their work, about which Mr. Feiss had spoken. He thought it was not necessary for the executive to be informed upon all the records contained in these charts, and a great many of them are not seen by the executive unless there is some particular thing for him to see.

The discussion was closed by David Myers, who said that he had dealt with one phase of efficiency, that which related to the factory power plant. He put forward a formula which seemed to him to sum up the whole situation very simply in two factors: the efficiency of any process was equal to the equipment modified by the human factor.

MACHINE SHOP SESSION, WEDNESDAY AFTERNOON

THE Machine Shop Session was called to order by H. K. Hathaway, Chairman of the Sub-Committee on meetings for Machine Shop Practice, for the reading and discussion of two important papers on Standardization of Machine Tools, by Carl G. Barth, and A Proposed Plan for the Activity of the Machine Shop Practice Sub-Committee, by H. K. Hathaway. The audience was pleased to allow Mr. Barth an extension of the ten minutes' allotted time for the presentation of his paper. He gave his arguments with spirited energy and conviction, and illustrated his talk with lantern slides and deft sketches on the blackboard.

The object of Mr. Barth's paper was to enlist the coöperation of the Society in encouraging machine-tool builders to adopt certain standards for machine tools. He believed that a universal speed series should be used by all machine-tool builders for all machines such as lathes, boring mills, milling machines, drill presses, etc. His ideal of the generally accepted geometrical progression of speed is represented in the progression:

1 $2^{\frac{1}{4}}$ $2^{\frac{2}{4}}$ $2^{\frac{3}{4}}$ 2 $2 \cdot 2^{\frac{1}{4}}$ $2 \cdot 2^{\frac{2}{4}}$ $2 \cdot 2^{\frac{3}{4}}$ 4 $4 \cdot 2^{\frac{1}{4}}$ ..etc., or

1 1.1892 1.4142 1.6818 2 2.3784 2.8284 3.3636 4 4.7568..etc.

His views on speeds hold also for feeds, except in the design of lathes in which the feeds for plain turning are obtained as a constant fraction of the screw-cutting feeds.

While the adoption of a standard speed series for all machine tools would be a step in the right direction, it would have to be accompanied by the adoption of a standardized amount of power.

For lathe centers, drill-press and milling-machine sockets, the speaker unqualifiedly recommended the universal adoption of Brown and Sharpe standards. He recommended the universal abandonment of the tang as a method of driving drills. The Barth key, with two sides beveled at 45 deg. and subject only to the crushing pressures, was adopted by himself some years ago as a drill drive.

Mr. Barth was extremely anxious that his paper be discussed freely by all present at the meeting, and the opportunity was taken by a few. William Kent's endeavors to learn why the Barth key was not supplied with beveled sides on both shank and socket sides resulted at last in a satisfactory answer after a keen competition at the blackboard and a threshing over of fundamental principles.

Adolph L. De Leeuw said that Mr. Barth had plainly showed how a good geometrical progression could be worked out and that it was an absolute necessity in all machine tools. Large boring mills, however, might be better without the geometrical progression as, when a large flywheel is turned, there is need for cutting at the rim and at the hub, but nowhere else, 90 per cent being cut at the rim and 10 per cent at the hub. Hence, the speeds should be bunched together to be correct for working at the rim and hub.

The time had come when the proper geometric speed series ought to be more closely studied. The attempt made by Mr. Barth to point out a geometrical progression which would be universally applicable deserved the highest praise. Personally, he believed that the progression as laid out by Mr. Barth was about as good as could be got under the conditions and with the knowledge we have at the present time.

The speaker regretted that there have been no investigations made on the art of cutting metals except for lathe work and for roughing cuts. Also, whereas everything possible has been done to study the matter of changing speeds on lathes, practically nothing had been done to provide for the necessary speeds and feeds on planers. The experiments on cutting angles had been carried on only through a small range. He said that he had personally made some little experiments with tools at an angle of not more than 25 deg. and found some very surprising results. He believed that if the Society as a whole would stand behind such efforts as Mr. Barth had spoken of, to standardize the range of feeds and speeds, much could be accomplished.

In an oral discussion, Harry V. Haight said that he agreed with Mr. Barth in the matter of belt feed. It had been his experience in the building of some two hundred lathes for munitions work that a 3-in. belt was sufficient to supply any demand for power and that any series of geometric progression of feeds could be obtained by changing pulleys. In contrast to this experience is that with expensive drill presses which were idle so much of the time because of broken gears.

MR. HATHAWAY OUTLINES HIS PLAN

Appointing Ralph E. Flanders to the chair, Mr. Hathaway took the floor for the presentation of his paper. Impressed with the fact that technical and scientific societies should be agencies through which constructive work leading to the development of a profession should be carried on, he proposed a definite plan of action for the Sub-Committee on Machine Shop Practice. He held that the sub-committee should classify the members of the Society with respect to the phases of machine-shop practice on which they were qualified to present papers, and should make a consistent effort to secure such papers.

A second and even larger undertaking would be the prosecution along predetermined lines of research that would result in definite advancement of the art. At present this is left almost entirely to the enterprise of individuals or companies, with no coördination of effort. Such work is now undertaken by committees of men whose time is so fully occupied by their own affairs that they can at best give an insufficient amount to the problem in hand. It would be better if the Society could employ experts who might give their entire time to investigation and research. A classification of machine shop practice had been worked out by the author and ap-

pended to the paper, arranged on the mnemonic system and so designed as to permit of easy expansion.

The interest in Mr. Hathaway's proposed plan was plainly evidenced by the discussion, written and oral, which followed its presentation. Mr. Flanders read three discussions, from Henry Hess, Robert C. H. Heck and R. J. S. Pigott. It is understood that the complete discussion will be published later.

Henry Hess pointed out that there are within the Society a number of committees which should concern themselves with the projects outlined in the Hathaway paper. The Committee on Technical Research is the logical agency to which investigation and experimentation should be entrusted, special sub-committees being appointed for definite tasks. A Research Committee is in existence but inactive, the Finance Committee having awarded it, unasked, "the munificent sum of $300" during the past year. The various Standards Committees sometimes concern themselves with certain phases involving research, but in too haphazard and uncorrelated a manner to secure the best work at the least cost. Special committees are occasionally appointed to deal with definite subjects, and could be aided by an adequate Research Committee.

Mr. Hess suggested a general supervising committee, not one that actually carried on research. It should originate or pass on projects for research brought to it, and advise the Council of the advisability of the Council's creating sub-committees, each to deal with a special line only. It would supervise the work of the sub-committees and the expenditure of the funds allotted to them, and strive to secure coöperation of other committees.

In closing, Mr. Hess said that it had been recognized by at least one engineering society that research of this character is quite within its functions, that it should be coöperative rather than left to individual effort, that it could be effectually carried on by such coöperation, and that effective aid and coöperation for the general benefit could be secured also from private interests that are quite ready to recognize that though their aid is to some extent altruistic, it is also directly beneficial from a personally selfish standpoint.

Prof. R. C. H. Heck made a plea for systematic information on cutting speeds, feeds, etc., not the extreme results of experiments that point the way to the future, but good routine average practice in up-to-date shops. This should be in the nature of handbook information, with due statement that practice is progressing and that quantitative values are subject to change. . . . What is wanted is, perhaps, a collection of well-selected examples rather than too definitely stated conclusions from such data.

R. J. S. Pigott, in full agreement with the attitude of Mr. Hathaway, stated that the principal difficulty in the way of getting adequate results accomplished is due to the utter lack of coördination between the various individuals and societies undertaking scientific investigation. One of the principal reasons for the comparative inefficiency of American manufacture is due to the attitude of secrecy which has all too frequently been taken.

Of the great mass of information on machine-shop practice available only a small amount has been collected by isolated investigators. A committee as outlined by Mr. Hathaway, having proper authority and a reliable system of effort, could do a great deal toward rendering this information useful to all engineers. The committee, to accomplish results, must be handled more like an operating company than a council of advisers. Mr. Pigott favored the Dewey rather than the mnemonic system of classification.

A. R. Shipley expressed himself as heartily in accord with the Hathaway paper. He dwelt upon the fact, brought out in the paper that engineers and men in charge devote too much time to the perfection of the design of their product and not enough time to the production of that product, a fact which is the cause of mismanagement in the machine shop.

Speaking of the small amount of literature dealing with machine shops to be found in the Society's publications, he said that more articles of a less technical nature are needed. Many papers given before the Society cover too large a field, and do not deal concretely enough with a specific subject. He believed that some such plan as outlined in the Hathaway paper would go a long way toward solving many of the difficulties which confront most manufacturers of machinery.

Henry J. Eberhardt suggested that the classification of data from technical journals, scientific transactions, foreign publications, etc., should not extend back further than one year at the outset, in order to determine how valuable further research into the past would be. He foresaw a possible danger in starting a large museum of ancient practice.

A much better method of using the committee would be to coöperate intimately with the Research Committee and to suggest to the commanding officers of U. S. Arsenals, Navy Yards, and others in Government service, and to the students in post-graduate technical work, the use of mechanical equipment in those various institutions for definite research work and tests. He cited the case of an inventor interested in the use of aluminum rather than bronze bearings for a steel shaft, and the impossibility of finding proper authoritative data. Tests made by the inventor himself would be narrow in their scope, but a well-planned test, using different diameters and a wider range of materials, might lead to practical discoveries.

The great opportunity for the Committee would be to bring before our members each year the best results of the past year's experience in typical shops. It was his hope that some such plan might be in full operation very soon.

"I wish to give this paper my hearty commendation and hope that Mr. Hathaway will keep on with the good work," said William Kent in opening the oral discussion. Mr. Kent believed that the machine-shop branch of the mechanical engineering profession had been given too little attention. The work to be done by the proposed Committee was to ask questions. Ten thousand questions might be asked of the men in the different shops, but it would first be necessary to have a secretary and a card index. Then, with questions asked and distributed around, it would be possible, perhaps, to have ten answered per year.

Mr. Kent favored the mnemonic system, which allowed 8000 combinations of three symbols, whereas there were only 999 possible with the Dewey system.

John J. Ralph thought few people knew how to buy machine tools. The prejudices of the buyer and the persuasiveness of the seller entered too greatly into the purchase. Nowhere was there a list of the basic facts which should be considered before a tool is bought. The various types of machine tools are not even known in the average shop. Catalogs and trade-paper advertisements constitute the principal source of information. There should be a standard method of testing machine tools for accuracy. There being specifications for the test and acceptance of boilers, why not for machine tools?

Elmer H. Neff suggested that The Journal devote a page per month to questions on machine-shop practice which required answers. He was certain that the results of experiences sent in response to the questions would bring the desired information.

Wm. T. Magruder commended the paper and said that the Gas Power Committee sometime ago had attempted similar work, but without results. The colleges would be glad to coöperate with the manufacturers if the latter would come to the colleges with their problems. If the problems were larger than could be undertaken by a single institution, they would be solved piecemeal by several of the colleges working together.

Other discussion of a commendatory character was offered by Chas. J. Simeon, Carl G. Barth, and others.

In closing, Mr. Hathaway explained that he could not then answer the points brought out in the discussion, but that his formal closure would appear later in the Transactions. He did suggest that the Committee must distinguish between questions of design and machine-shop practice. It should confine itself to questions of practice.

FIRST VALUATION SESSION, THURSDAY MORNING

THE First Valuation Session of the Annual Meeting was held on Thursday morning in the Auditorium, Vice-President Henry Hess acting as Chairman. Three papers were presented for consideration and, since all of them dealt with the same general subject, were read in succession before the discussion was opened, the first two by their authors and the last by the Secretary, in the absence of the author. The first paper was by J. G. Morse, entitled Accurate Appraisals by Short Methods, in which the author described the method of appraisal developed by the Associated Factory Mutual Fire Insurance Companies, which combines approximation with theory, and is much shorter than one necessitating a complete and elaborate detail. The second paper, by Prof. John H. Gray, was entitled How Does Industrial Valuation Differ from Public-Utility Valuation? and dealt with the valuation problems growing out of governmental attempts to regulate the various public-service industries. The final paper, The Relation Between Perpetual-Inventory Value and Appraisal Value, by Charles Piez, emphasized the necessity for determining proper rates of depreciation in order to establish true costs of products.

MR. GANTT OPENS THE DISCUSSION

H. L. Gantt, being called on to open the discussion, said that things had so changed in the world in the last two years that a great deal that Professor Gray said, he thought, was a little out of date. It might be good law, constitutional, and proper, according to our viewpoint of a few years ago, but we were thinking in different terms today. The war had taught Europe something. England had just made a change and put Lloyd George at the head of the Government. They had brushed aside the powers that had controlled, and had put the power in the hands of the man they believed most capable of "delivering the goods." Our laws and our regulations would have to be so adjusted as to produce the greatest possible values for the community. England, to save her life, had been obliged to do that.

We were in a class with England, and had not learned from the war as England had. If we were ever confronted with the same problem that England was, our salvation would come through the men who knew how to do things, and a solution of our problems would be in the hands of our engineers rather than our financiers.

Professor Gray's paper related to a condition of affairs when the financier was the supreme power in the world. Today the engineer was successfully disputing that power with him in the warring countries.

No theory of valuation would be complete in the future unless it took account of the value of the engineer, and Professor Gray had left this entirely out of his calculation.

A. E. Flowers asked for a definition of the term "reducing balance" employed in the table of depreciation rates in Mr. Piez's paper.

In the absence of the author, Carl G. Barth explained the term, stating that if a machine was worth $1,000 today, and it was depreciated 10 per cent on the reducing balance, it merely meant $100 for the first year, and 10 per cent for the second year, and that left 90, and the amount would never be entirely extinguished. If a machine depreciated 10 per cent a year, however, its value would be wiped out in ten years.

Speaking to the papers, he was convinced there had not been a single improvement made on the accounting and cost system that Mr. Taylor invented twelve or fourteen years ago. Mr. Taylor had started out with the idea that the simplest way of proceeding was to get a cost that was such that the difference between selling price and cost price was absolute profit. There was no question about that being the correct point of view. He wanted nothing to go into the cost except the things that had been expended or lost in carrying on the business.

Regarding Professor Gray's paper, Charles Whiting Baker thought it incorrect to state that the reason for establishing public regulation of utilities had been to stop speculation. It had been the shippers, the travelers, the people who bought gas and electricity, who rode in the railway trains and cars, who were behind the great movement that demanded public utilities should be regulated, rather than innocent purchasers of worthless securities. He was unable to understand why Professor Gray did not accept the cost-of-production theory of valuation, as it seemed to him to lie at the base of our whole work of valuation. In all our valuation work it was necessary to go back to this theory. Suppose a manufacturing concern were to issue a balance sheet showing what its property was worth, based on its earning power. Now, its earning power would vary from year to year, and every competent appraiser knew that the only safe way to value an industrial property or a manufacturing property was to value it at what it would cost to replace the buildings, put the machinery back there, and duplicate the plant as it originally stood. Why? Because in the nature of the case some other competitor might come along the next day and duplicate the property and go into the business; so the only safe way for a fair valuation was to base it on the cost of reproduction.

DEFINITIONS DEALING WITH DEPRECIATION

In a written discussion of Mr. Morse's paper, Harry Barker[1] contrasted the high and burdensome costs of public-utility appraisals with the moderate figures resulting from the use of the author's method. In his opinion, the pioneer utility appraisers had felt impelled to present an impressive array of evidence and to substitute for experience and ac-

[1] Associate Editor, Engineering News, 10th Ave. and 36th St., New York.

cumulated data a logical system of scrutinizing property details. The older commissions, however, should have accumulated by this time sufficient data to be able to adopt the author's methods if that were deemed desirable. It would be helpful to learn how the author would apply his methods in cases in the utility field where the effect of seeking out original conditions of construction might change the valuation result by 100 per cent or more over figures based on present conditions as superficially indicated.

Turning to Mr. Piez's paper, Mr. Barker said that the fundamental term "depreciation" had become so involved in a maze of differing definitions, that even when engineers endeavored to use it quite technically it conveyed different ideas to different persons. In an attempt to harmonize some of these differences he had been led to study the various meanings attaching to the term, and had found that it was possible to clear up matters by employing six definitions, having different shades of meaning, which definitions he appended.

In a written discussion commenting on the possible value of a valuation, L. K. Frank[1] said that it was not improbable that industrial property might be subject to public regulation of return on investment before the close of the century. The Federal Trade Commission was advocating the adoption of accounting methods by the manufacturers of the country, which in many instances would call for valuation work, and upon the care and industrial statesmanship of the engineers involved would depend the future course of this movement for social control of industry. Social progress was inevitable, and it was open to the engineers to play a part in this movement, the importance of which could scarcely be measured.

The Chairman called on Dean M. E. Cooley, who, among other things, said that he felt a degree of responsibility concerning the use of the word "depreciation" in connection with appraisals. It came up in connection with the appraisal of the Michigan railroad properties in 1900, and had come to play a very important part in the decisions of the various State Commissions since organized; a most unfortunate part, he might add, for it was not entitled to have the use that had been given it, and should be discarded in certain classes of investigations. For example, there was now in process of solution a valuation problem of a very large utility property not far from New York, which involved the depreciated value of the property as observed. It was a complex electric light and railroad property, involving many plants, old and modern. In the old plants the machinery was about ready to be discarded, and the machinery of the new plants substituted. The question was as to the value of the machinery to be discarded. It had perhaps been valued by observation, being 20 or 25 years old, at, say, $180,000, and the question raised had been whether that was a fair value. So an investigation had been made to determine its present real or commercial value, comparing it, in an economic way, with the machinery of a new plant. Considering the distance between the two plants, the necessity for constructing transmission lines, and the necessity for wiping out in a sinking fund or otherwise whatever value there might be in the old plant, the commercial value of the old plant today, instead of being $180,000, was about $360,000!

DEPRECIATION NOT INVOLVED IN RATE CASES

The word "depreciation" had no place whatever in the investigation of a rate case. For example, a railroad was made up of a vast number of elements, all new in the beginning and each having, say, 100 per cent value. After a few years the elements—ties, rails, locomotives, cars—wore in various degrees, and were replaced by new elements. After, say, twenty-five years this property would come to a stable condition and would continue to exist in perpetuity in a condition less than 100 per cent for each of the elements, but in a condition which might be expressed, say, by 80 or 85 per cent. It could be demonstrated very conclusively that to attempt to maintain such a complex property at a higher percentage than what we call its normal percentage would be a waste of money, because elements would have to be thrown away or discarded before they were worn out. Also, if the property were maintained at a very much lower percentage it would be equally a waste of money, because the property itself would be endangered and the business which it could do would be diminished. The property could, in this 80 or 85 per cent condition of efficiency, render the maximum service which it was capable of rendering. To obtain it in a normal condition, expressed by 80 or 85 per cent, we had had to expend 100 per cent. Therefore, that was the investment, and it could not be had for anything else. If there was 100 per cent investment in that property standing at 80 or 85 per cent condition, as we value it, there being, say 15 or 20 per cent depreciation, then we should allow in a rate-making case 100 per cent, and depreciation would have no purpose whatever in the problem.

The word "depreciation," however, did have value in other cases, and it might have value in a rate-making case where, for instance, the financial policy of the company had involved the laying aside of money which the English would call a "sinking fund" to back up the difference between the 100 per cent and the 80 or 85 per cent. If the earnings had already been sufficient to enable that to be done, then perhaps we should take the 80 or 85 per cent for the rate-making purposes rather than the 100 per cent, but in America we took our sinking fund in the form of dividends.

THE PRODUCTIVE LIFE OF A PLANT

L. S. Randolph stated that he had had a great deal of difficulty with the word "depreciation," and in figuring out such questions attacked the problem in the beginning by assuming that a piece of machinery or plant could be so repaired or renewed as to do the work as well as when first erected. After that it was a question, first, of using the word "obsolescence," and then the term "productive life," or, in other words, what would be the productive life of a plant, and that, he thought, would have to be laid aside to return the value of the original investment of the plant when the productive life had ceased. He had come across some cases—in agriculture—where apparently the productive life was infinite, and where there was actually appreciation of value. Sometimes legal enactments would abruptly cut off the productive life of a plant.

Engineers, Morris Knowles thought, should be very much interested in such a paper as Mr. Morse's, because the fact was obvious that appraisements were costing enormous sums of money. There was much unnecessary refinement, and in the end the people, the rate payers, were paying for these things. In Pennsylvania all matters of fact were referred to an Engineering Board consisting of one engineer appointed by each side and the chief engineer of the Commission sitting as chairman. Engineers when they faced each other across a table understood whether each one knew what he was talking about, and they did not have to count all the bolts and nuts and gaskets which were used in a steam pipe to determine that a certain number of boilers cost so much money. They could

[1] 15 Dey Street, New York.

persuade each other, and it was different from trying to persuade an attorney or the Court.

He would like to differ from Professor Gray in one respect, and that was that valuation in amount necessarily depended on the purpose. The report of the recent case of the Los Angeles electric situation went into that thoroughly, and showed if you could affect the rate as to value for rate-making purposes, this value should be used for other purposes. Certainly in the case of a purchaser the value would control, because he would not want to pay any more for the property than what he thought he might get out of it if it were subjected to regulation.

Referring to Dean Cooley's remarks about depreciation, he thought that if a depreciation fund was in existence, then the property was entitled to earn on 100 per cent; but if the utility had not that fund on hand, but had pocketed it, it would not be carrying out its trusteeship to the people, and therefore depreciation should be deducted.

In regard to the question of valuation on the basis of cost of reproduction of a plant, William Kent stated that there were some cases where he thought it might not apply very well. For example, what had been the valuation of the power plant of the Interborough Rapid Transit Company two years ago, when it had been equipped with magnificent alternating-current generators driven by engines of the very highest type known, and these engines were as good as new, for all practical purposes, and had cost $1,000,000, or twice that, probably? On the cost of reproduction you would say that you would value that plant on the basis of those engines in use, but if the owners of the plant had decided that these same engines, good as they were, were using more steam than more modern engines or turbines would use, and it had been necessary to throw them out and put them in the scrap heap, and spend two millions of dollars to replace them by turbines, then what was the valuation of the plant before the contract for turbines was made? It certainly was not the cost of reproducing the plant going into the scrap heap. Some allowance for valuation would have to be made on the reproduction basis.

It seemed to him that we had not arrived at any proper theory of valuation because we had no leaders of thought on this subject who represented the public. We had had court decisions by judges who were not experts, but who did the best they could with the limited light they had, but no authoritative statements by leading lights representing the public at large, and that was what we were looking for. He thought we could get such a statement some day from engineers rather than from lawyers. It was a question of strong common sense rather than of the traditions of law. What was needed was a few strong and intelligent students of the matter who would put their ideas together and get the question solved on the basis of exact justice between all the parties concerned, especially justice to the community that paid the bills.

TWO KINDS OF OBSOLESCENCE

Oberlin Smith said that his rule was that things were worth what it would cost to reproduce them tomorrow if they were burned today in their present condition. With a plant all new, it would mean the cost of a new plant. That might be more, or less, than what the plant and its contents had cost. They might have appreciated or depreciated since they were new. On everything new it was necessary to find the percentage of obsolescence and take off that percentage, but in a machine shop it did not pay to have that value too low, as the tools were not efficient unless they were kept up, as Dean Cooley said, to 80 or 85 per cent efficiency, so that they did work, and to rate them at that was evidently fair. The principle of obsolescence might put them down to nothing.

There were two kinds of obsolescence. One kind would be the tool not being up to date, and we could apply that theory to a certain extent, so if it were likely that the tools would have to be altered or repaired, that should be taken into account in the valuation. The other kind of obsolescence was the change in the demand for the product. Certain things would be in fashion at one season, and then become obsolete, and the tools for making them, although as good as ever and in absolutely first-class condition for performing their functions efficiently, would be of no use for their special purpose; and so we had to take into consideration, and be on the lookout constantly for, the obsolescence of tools which in themselves were up-to-date and efficient, but for which there was no employment.

Some people depreciated a set of machine tools ten per cent each year, and that soon made them worth one-half or one-quarter of their original value, when they were as good as ever. His rule had been to allow a certain small amount for depreciation each year and keep the tools in good order. If a tool was run down and needed repairs, or an additional part was applied to it, then it was worth more at the end of the year when repaired, and perhaps 50 per cent of the original value spent on it, and it was not right to keep depreciating it right along. It was worth as much as when new, and under this method of allowing for depreciation we kept the inventory jumping up and down.

The public utilities were an entirely different matter—they were things which had a value outside of the actual plant value. The plant value of a concern might be 80 per cent of its original cost, say, or anywhere up to 100 per cent, and the concern might be sold out at a 200 per cent valuation because of surplus which had accumulated by extra profits, unpaid dividends, etc., so that the commercial value of the plant should not be taken as the actual value, the mechanical value of the plant, because the plant itself could be reproduced for the 100 per cent, and all this extra was in the form of good-will. If a plant sold out for 200 per cent of the cost, it would be because of earning power, and earning power had to be taken into account when we valued the plant for the market for selling it, or perhaps for taxing it. We should consider that a plant was not necessarily more valuable because of its great earning power, for that earning-power increment belonged in what he termed "good-will" or anything we would like to call it.

DEPRECIATION PURELY AN ITEM OF OPERATING COST

Accountants and engineers, thought W. L. Whittlesey,[1] should have the same point of view of operating facts, and an accountant might be excused for saying that depreciation was an item in operating cost, for it was not anything else. If depreciation meant anything it was an item of operating cost and nothing else. The idea of a public-utility corporation was that it should do two things: it should enlist and develop ability within its ranks, and it should give service to its patrons. In the future the problem of regulation might be taken up in that way, but the trouble was, of course, that the lawyers took it up as a matter of property, and so there were such expensive valuations as that of the New York Telephone Company, costing $3.00 per thousand of value; but the idea

[1] 15 Dey St., New York.

there had been to do a thorough engineering job, to head off any inquiries of this sort, and to put an end to a situation that had been dragging along for about ten years. Another valuation fact lay in the change in the price of copper; this, every one knew, had tripled within the last year or two. A few years ago corporations had had a base figure of 16 or 17 cents per lb., and talked about writing down the fixed value of assets which depended on the price of copper, as the valuation was too high, and now the valuation was about half the market price!

Oberlin Smith thought that the best way to thresh the matter out would be for the Society to appoint a committee, perhaps a permanent one, on valuation, and work in consonance with other societies. In his opinion there should be a distinction between the mechanical value of a plant and the commercial value, the increment being placed on franchises and the earning power and various things of that nature. This was not a time to make valuations, because the whole country and the whole world were in an abnormal state, and no present valuations would be indicative of what they might be after the war was over.

Referring to the paper of Mr. Piez, in which he presented a schedule of depreciation in rates, John L. Harper said that financiers often asked their engineers to present to them certain factors for determining the amounts to be written off each year, depending on the conditions existent at the time, and it was along that line he wished to inquire of the author as to his method of determining these factors in relation to the salvage values, and the fluctuations in actual values of the materials covered in the several items.

Edward W. Bemis,[1] in a written communication dealing with Mr. Morse's paper, stated that in his opinion, unless both sides agreed, the side not giving a detailed appraisal would be at a disadvantage; and that only great reputation on the part of the appraisal company would enable a short-cut appraisal to stand up against a detailed one. Unfortunately, most of the appraisal companies of large reputation had applied such high overhead charges and so strongly endorsed going value as to be looked on with distrust by cities. Personally, he believed that where both sides exhibited a cooperative spirit, short methods could be employed which would yield justice to all concerned.

DETERMINING THE VALUE OF A PLANT

In a written discussion of Mr. Morse's paper, Chas. T. Main said that for the purpose of purchase or sale, for condemnation, or for establishing a fair cost value for accounting purposes, it was unnecessary to make elaborate schedules of all the items in a plant; oftentimes a rough approximate value per unit, such as a spinning spindle, was near enough, if the plant was what could be termed standard.

The first step in determining the value of a plant was to ascertain its replacement cost, and then to compare this with the cost of a new plant constructed on modern principles, the output of which would be equal in amount to, and of as good quality as, that of the existing mill. A comparison should then be made of the cost of running the two mills, and if the organization of the existing mill could be so changed as to make it as efficient as a modern plant, the cost of such change would be deducted from the replacement cost. If it could not be changed, the greater annual operating expense would have to be capitalized to some reasonable per cent and the capitalized sum deducted from the value new.

After thus determining the value of the plant, if new, account had to be taken of depreciation. To be safe in accounting, it was necessary to mark off each year an amount that would fully cover all possible decrease in values from age, wear and tear, and obsolescence; but if this were carried too far the value on the books would become less than the true value, therefore revaluations should be made at stated periods, say every five years, at which time the write-off for obsolescence for that period, at least, might be readjusted and corrections made for decided changes up or down in replacement values and for any extraordinary repairs or renewals.

In a general way he had found that the useful life of the common types of machinery that had been run about ten hours a day, had received the usual good care, and had not been superseded by machines that would render them unprofitable to run, was about 30 years for cotton machinery and 50 years for woolen and worsted machinery. Well-designed and substantially built mills, when properly kept up, should be good for 100 years.

In appraising a property in operation, there should be added to the physical value the "going concern value," or the amount required to get it started so that goods could be marketed. This amount was made up of (1) interest during construction; (2) engineering expense; (3) interest, depreciation, taxes, and insurance for the period required to start up the mill and get the goods on the market; (4) cost of starting up; and (5) allowance for wastage and damage to product. He had found that for the sum of the first three items it was safe to take 10 per cent of the replacement cost, and for the remaining items, 5 per cent, or a total of 15 per cent.

Chas. W. McKay,[1] in a written communication discussing Mr. Morse's paper, outlined a method of manufacturing-plant appraisement patterned after current practice in public-utility valuation work. He also said that, while the author's plan of appraisal by short methods might satisfy his clients, or his employers, who had sufficient confidence in his judgment and knew full well that he would be able to substantiate his valuation in the event of a call for claim adjustments, nevertheless it was quite probable that insurance organizations would be somewhat loth to accept valuations made by outside engineers and based upon the author's rather broad-gage methods. And it was probable that an engineer in submitting a short-method appraisal would experience considerable difficulty in getting the court to accept it in the event of a law suit over the value of a manufacturing property or in using it as a basis for capitalization. He thought that the auxiliary building equipment, such as elevators, piping and wiring, should, so far as possible, be considered a part of the building rather than as a part of the machine equipment. While some of the appraisals prepared by the so-called appraisal companies contained needless detail, the short-cut methods of Mr. Morse, on the other hand, seemed to him to be a little too approximate in their nature to warrant their general adoption for engineering valuations. Probably there was a happy medium between the two plans, which could best be reached by observing, and to a certain extent copying, the methods adopted in the public-utility appraisement field.

COMPROMISE WITH UNWARNED INVESTORS NECESSARY

In a written discussion of Professor Gray's paper, Robert L. Hale said that, unfortunately, people had been permitted to invest in public-utility companies with the expectation of get-

[1] City Hall Square Building, Chicago, Ill.

[1] With McMeen and Miller, Engineers, 1454 Monadnock Block, Chicago.

ting more than was necessary to induce investment. As a result, justice might compel us to permit these unwarned investors to continue in the enjoyment of the returns for which they had paid, but this did not prevent us from adopting a policy of warning future investors as to just how much they would be permitted to earn, and of preventing the value of existing investment from becoming more swollen than it now was. He desired to emphasize the fact that the problems dealing with warned and unwarned investors were entirely dissimilar and should be treated separately.

In regard to past investors he thought some form of partially unsatisfactory compromise necessary. If the courts meant that they were entitled to a fair return on the exchange value of the entire business, then no reduction in net earnings was permissible. But if they meant to permit a fair return on the exchange value of the "property," and meant to distinguish the value of the property from that of the entire business, then the cost of replacing the physical property with an equally efficient substitute would throw light in some cases on the value of the property as distinguished from that of the entire business.

When it had been decided how much return should be permitted to any public utility, there was no reason why anything more than that return should go to it for accidental reasons. It therefore seemed best to permit a rate which would be pretty certain to result in a return as great as that which had been decided on as permissible, and then to hold the company responsible to the public for all the excess above that return, either by paying it back into the public treasury, or by putting it back into the plant without adding to the amount on which it should earn a return in the future.

Discussing the paper by Mr. Piez in a written communication, Robert J. Hearne said that the subjects of inventory, cost, and valuation were so interwoven that they should be treated together. Too many valuations, he thought, were colored by future prospects. On the other hand, one could not ignore present conditions. While abnormally good now, a new basis for valuation would arise with a change in times. Valuation had to be recent to be of any good.

In actual practice, extending over many years, he had found it practical and necessary for the purpose of inventory to make (1) an estimate of actual cost, (2) a conservative valuation for his own guidance, and (3) a valuation for insurance purposes. He thought that the work attempted by appraisal companies should be done by one's own employees. At the best, outsiders could only deal in figures, not facts; they could not possibly know the business itself. They did have a value, however, in detecting fraud and incompetence.

Properly kept, a perpetual inventory was a time saver and a daily corrector of values and costs, and kept everything up to date. It took some trouble to install and some thought to keep going, but it paid. He had had over 15 years' experience with a method that was adapted to almost any business, that saved time, trouble and expense and that could be applied to a new business very easily and to an old one a little at a time. The discussor then described in detail the method mentioned.

AUTHORS' CLOSURES

J. G. Morse, in closing the discussion on his paper, said that the fact that there were so many different opinions in regard to depreciation, and what should be considered depreciation, made it all the more unnecessary to go into detail. As to the cost of his appraisals, he thought the range was from 15 to 25 cents per $1000. He had been asked to outline his procedure in the case of an industrial property. He understood that in Vermont, in appraising the telephone company, they measured the length of every pole and put a different price on each pole where it varied six inches in height. He would have taken an average price per pole, and ascertained the number of poles to the mile and the number of miles of line the company owned, and obtained the value by using that factor. He would have averaged the poles and wires in that way. In the case of a railway valuation, he would take the track at so much per mile; he would take the trestles according to their construction and classify them into different types, at so many dollars per lineal foot. In short, he would go over the property, naming a unit factor on every part of the property and apply it; going into detail in each individual case for one sample only.

Prof. John H. Gray, in closing the discussion on his paper, began by saying that anyone who thought that railway capitalization did not affect rates, should recall the traction history in New York and Chicago between 1899 and 1907. The things that started the movement toward regulation were, first, fluctuation in rates, and second, the enormous fortunes made by speculators. They were the red rags that stirred up the agitation.

As to the cost-of-reproduction theory, he did not accept it, first, except as it served to put the value up with the social growth, and therefore to give the benefit of the unregulated industries to the people who were fortunate enough to have bet satisfactorily upon the rapidity of the social growth, because it was absolutely inconsistent with any regulation at all. In the second place, he did not accept it because, if he understood the development of human society, in the long run it would conform, not to the precedents of the law, as someone had said, but to the necessities of economic and social life. The cost of reproduction arrived at something that anybody who understood the situation and was dishonest wanted to find. In the next place, it was primarily a subject of cost, and if our social system was to be organized on the basis of cost and mere speculation, we would go to the bow-wows, and we had better get down to the facts. He was opposed to the cost of reproduction because no one wanted to reproduce one of these important properties. In the next place, there was no human experience on which to base an intelligent estimate as to how long it would take to reproduce the property, or how much it would cost.

We all agreed that the public utilities were necessary for the maintenance of our civilization on its present basis. The company wanted its monopoly guaranteed, and wanted its monopoly profits. In the final analysis we had got to have the industries carried on, and if we allowed private capital to do it, we should have to allow a rate of income that in the long run would induce men to put in capital enough to meet the requirements of these enterprises and to meet the needs of the growth of a progressive state of society. It had nothing whatever to do with value. It had to do with the contribution of money and service, and service could not be measured in money. The State did not allow them to discontinue service. When land went up in price they were not allowed to sell the land. The land was dedicated to that particular purpose, and in many utilities it had been acquired by the company with a limitation for a particular purpose, and not by the exercise of eminent domain, which was a controlling element.

In reply to a question by Clarence H. Tolman in regard to the capitalization of losses, Professor Gray said that if we were going to hold the company down on the present law to what was called a fair rate, both the custom and the tendency

were to make that rate uniform. The tendency, therefore, was to hold the company down in prosperous times to the average rate. In lean years, though, there would be losses. That being the case, he would say that the public had got to guarantee the losses, provided they were not vicious, fraudulent, or grossly reckless, for if they were not compensated for in some way, capital would cease to come in and the service would suffer. The viciousness of the cost-of-reproduction proposition, and the viciousness of all intangible propositions, was not that the man ought not to have some compensation, but in the method of giving it. That was what was wrong, and this method of cost of reproduction, in his judgment, had been the reason for one of the most powerful movements toward public ownership, and he assumed his hearers knew that the traditions of the organization of our Government were wholly inadequate and too antiquated to manage business effectively; but he thought these losses should be set up in an amortization account, and should have a temporary larger rate of income, but should not be permitted to disturb the capitalization.

SECOND VALUATION SESSION, THURSDAY AFTERNOON

THE Second Valuation Session was likewise held in the Auditorium, and was called to order by Chairman Hess, at 2:15 p. m. Two papers were offered: the first, by Walter N. Polakov, entitled Valuation of Industrial Properties vs. Valuation of Industrial Methods; and the second, by H. L. Gantt, on Productive Capacity a Measure of Value of an Industrial Property. The procedure of the morning session was followed, both papers being presented before discussion was begun.

In his opening remarks, made in lieu of a formal presentation of his paper, Mr. Polakov referred to the Chinese custom of the bridegroom paying for the bride, in accordance with her worth, a ransom to her parents. That ancient practice, it seemed to him, prevailed in our day when we put the value of the plant in accordance with the equipment of these plants, and neglected to consider what the plant was capable of doing for society. The modern financier seemed to have difficulty in getting rid of the habit. The other day his opinion had been asked as to how much more equipment a certain mill would require in order that appropriation might be made for it. It was desired to increase the output from 13 tons a day to 40 tons a day, and an actual test had proved that they had the capacity to produce from 60 to 80 tons a day, but for some reason or other they had not done it. That was evidently due to a lack of method. How we were to appreciate or appraise this method, and the methods in vogue, seemed to be a question which should be answered before we went into the question of how much of the equipment was necessary, and what part of it we knew how to use, and what part of it we did not care to use, for some reason or another. The substance of the matter was that people had not yet realized the fact that those who did not know how to run a business for the benefit of the industry should be denied the privilege of running it at all.

Cases were known of important railways that employed their extensive equipment but 20 per cent of the time, leaving it idle 80 per cent of the time on account of poor planning. Certain electric railways, for some reason or other, had preferred to keep their power plants and equipment idle two-thirds of their capacity and buy power from outside sources for double the price that they could develop it for themselves. Yet this idle equipment was, in fact, not an asset, but a liability to society. Some one had to pay for it—the consumer—and in his judgment it was the duty of the engineer to reverse this condition of affairs as much as he could.

MR. GANTT'S INTRODUCTORY DISCUSSION

Mr. Gantt, on being introduced, began by saying that inasmuch as the value of an industrial plant was measured by its ability to produce values, such a plant, which was not operated, had not actual but only potential value, and actual value was conferred upon it only when human intelligence and industry were added to it to produce the results for which it had been created. The fact that industrial plants were created in order to make some article which could be sold at profit, or to render some service which could be sold at profit, amply justified the statement that their value was dependent upon how they performed their functions. One might therefore divide the value of a going industrial property into two classes—that of the potential or static value of the plant itself, and that of the dynamic value of the organization operating it. In the past, the former had been given attention by accountants, almost to the entire exclusion of the latter, in spite of the fact that the stock-market prices and sales values of plants actually, though indirectly, reflected both values combined. If we would get a clear conception of a going plant, we would have to find the means of measuring the value of the operating organization, which had often far more to do with its successful operation than the particular constructions and equipments of which it was composed.

In the operation of an industrial property, it was seldom that all the expense incurred during any one month could be utilized to advantage; but if we could find how much was utilized and how well it was utilized, we could get some idea of the efficiency of the management. How well the money used was used, was indicated by the cost of the article produced; but there had, in general, been no indication as to what became of expense incurred but not utilized. How much expense was incurred but not utilized, and why it was not utilized, were vital factors in any attempt to measure the efficiency of the management; hence it was to these questions that we gave special attention in this paper.

At the Buffalo meeting last year, he had read a paper on the relation between production and cost, wherein he had contended that the true cost should include only those items needed to produce the article, and that any other money expended while these articles were being produced for any cause whatever should be charged to some other account. People were pretty generally keeping an account of the money expended for producing articles, but in few cases were they taking care to find out how much money was expended that did not produce anything.

We were all familiar with the fact that idle machinery cost money, even when it was idle. Interest on the money invested, taxes, depreciation, insurance, etc., all went on whether the machinery was used or not. The value of a plant was very materially influenced by the amount of the above items that were unused or unusable.

This was a factor which was directly in the control of the management, and did not in any way concern the inefficiency of the workman, but it was a real factor in the valuation of

a plant. Hence, a chart of the nature shown in his paper was a very real help in determining the value of the going plant.

Referring to Mr. Gantt's chart, W. S. Rogers thought if it were real it would show the unbalanced condition of the plant. That was just as important as anything. The divisions could be carried out further, and show plainly and clearly inefficiency, and the chart would point to and almost name the man, up in the higher office, who was killing himself at his desk, absolutely unable to go out and get a meal, almost, and the biggest leak in the plant, knowing the least about it.

AN INSTANCE OF THE EFFECTIVENESS OF CHARTS

Carl G. Barth said that he wanted to bring up the question of the human element. He did not think there was a better way to treat a man than to give him a good machine to work with, and that was the reason he started in first with the machine. He was not so enthusiastic over making time studies on all routine operations, and had been with four companies without taking a single time study on the Taylor system.

Charts like the one shown had been made under cover, but they had not been presented before the Society heretofore, and he was thankful to Mr. Gantt for having done it. A similar chart was now being carried out with a great deal of detail at the Winchester Arms Company, and it showed the various items by lines instead of percentages, which in his opinion was far more effective. He had been with a certain company and they had increased the production 2.5 per cent. He had then sent in a report to the president that they were then using, with the increased percentage, a little over one-half of the equipment of the company. Mr. Taylor had done the same thing.

In regard to machine idleness, William W. Crosby stated that it was known among textile mills that parts of looms for a whole year at a time were in the storehouse. They had tackle and slings, and looms were put into operation at certain times because certain grades of cloths were demanded, but at other times they were not required. With a sufficiently world-wide market we could keep our mills running at somewhere near the capacity for which they were designed, but you could not run mills fully and economically unless you had the orders to run them on.

HOW PROFITS SHOULD BE FIGURED

H. B. Cheney[1] was of the opinion that every mill had some factor which, running on a particular product, was the controlling factor. For instance, in Mr. Gantt's cotton mill it was probably the looms. You could not make any more goods in that mill than the looms could turn out. Consequently, when it came to making a chart, such as Mr. Gantt had, the idleness portion of the chart should show, as he had arranged it, upon the 100 per cent method; but when you came to the factors or rates upon which you were making your calculations of cost, that policy should not be longer continued. You should take the controlling factor of your mill, your looms, your spindles, whatever it was that controlled the product of the day, and say that all the other departments which were necessary to supply those looms were supply departments, and if your looms ran 100 per cent, that 100 per cent of all the expense of having that department supplied should be consumed in your cost; but if your looms, which were the controlling factor, only ran 85 per cent, then only 85 per cent of all the rest of the overhead should be consumed. All the departments having a chart on a 100 per cent method would show you just the things Mr. Rogers had referred to. It did unquestionably bring out with the greatest clearness every point that was out of balance for that time. But it might be an entirely different matter six months later.

Heretofore it had been the custom to figure profits upon a percentage made upon the article sold. He did not believe it was the right basis to proceed on. What was the most profit that could be made out of a given plant? It was not necessarily that made by manufacturing the article which showed the largest percentage of profit upon its cost, but that which showed the largest profit for the machines run. Therefore, profits, instead of being figured on the article made, should be figured upon the running of the machines. In other words, one article might earn $1.00 a day profit on a loom, and another one $5.00 a day, and the article which earned $1.00 a day might make 50 per cent profit and the one which earned $5.00 a day but 10 per cent profit.

As to the human element, there was one factor in connection with that which he wished to bring out, which was that heretofore men had usually been hired without any particular reference to the efficiency of the individual for the work which they were intended to do. You could not take a man without any regard to his adaptability to it, and force him into a certain mold from the beginning to the end, training him without finding out, when he came to that point, whether he was the best man that could be trained for that particular purpose, and expect to get satisfactory results. He believed it was possible, and would be possible, to apply gages and tests for the purpose of determining the efficiency of the unit before putting it in use.

As to Mr. Gantt's chart, Frederic G. Coburn thought that one of its chief points was that it would show how much it was costing one for idle time. Granting that seasonal requirements and styles would affect the textile mill, at the same time it was known that goods that had twisted yarns in them cost more than those that did not. If you applied the overhead on the loom-hour basis you would lose sight of that—you would not know how much more one fabric cost than another.

In his line a big boring mill would be idle three weeks out of a month. This chart would tell how much that idleness was costing, and it would give some guidance in going after a line of business that would keep the equipment going, and while his concern did not have to combat styles and seasonal variations and conditions that would bring business for a 16-ft. boring mill, at the same time they would have an eye on the chart and would do better and know how much they failed of accomplishing the desired end.

H. M. Wilcox told of results secured at the Winchester Arms Company from a set of charts similar to Mr. Gantt's, only carried out in a great deal further detail. They had studied the idle machine time in the cartridge-manufacturing department for a year or more, and determined how much time they were losing from the possible productive time of the machines due to tools, to machines, to labor, and to excess equipment. They had carried on that analysis so that they knew how much time they were losing due to keys, due to indexing devices, due to setting up of machinery, and changing over of calibers. This had directed their energy toward the point where they were weakest, in eliminating the idle machine time by giving their foremen information in regard to where time was being lost. They had loosened up a great mass of energy which they really did not know they had theretofore. They had made the jobs interesting to the men without any

[1] South Manchester, Conn.

effort other than pointing out where they were losing time, and had gained vastly in production from the activities of the shop men themselves. They had added to the cost of the idle time the cost of scrap, and called it their cost of lost effort. That had nothing to do with the salable cost of the goods. They gave a report of all lost effort to the foremen weekly, and the foremen had responded in attempting to reduce this waste, which was absolutely all waste, as far as operating interests were concerned. He wanted to mention that, to show that they were all working along the same lines.

SUGGESTED MODIFICATION OF MR. GANTT'S CHART

William Kent thought that in a textile mill it might be possible, if the mill were large and made but one style of goods, so to balance the machinery that none of it would be idle more than, say, 10 per cent of the time; but if many different styles were made, the demand for which varied with the season and with the fashion, the weaving machines might be running full time and not be able to take the whole capacity of the spinning machines, some of which would therefore have to be idle part of the time, or to utilize the full capacity of the finishing, inspecting, and shipping departments.

The "expense actually needed" for the production of a variety of articles might thus include a part of the idle time of machines necessary to have on hand to care for a varying demand, but which could not be kept continuously employed; and in such a case it was right to charge some of the cost of idleness into the "normal burden" which was distributed in the machine-hour rate to the cost of the goods. This rate should be determined annually for each machine, after studying statistics of preceding years, and it should include an allowance for the average or normal time that the machine might be expected to be idle during the coming year. A modification of Mr. Gantt's chart was thus suggested to show how much of the idleness of a machine or department was normal and necessary to the conduct of the business, and how much was abnormal and excessive. This might be done by drawing vertical lines on the percentage portion of the chart indicating the normal percentage of full capacity which each machine or department was expected to run during a month of good business. He also thought the expression "value of the property" used in the paper was ambiguous and that its meaning should be defined.

Referring to Mr. Gantt's chart, John E. Mullaney stated that after his company had used it for about a year, he thought it might be worth while to know that if during the time they had been actually charging expenses to the operation, they had been getting out their product at the fullest efficiency. In order to show that they had tried the idea of drawing a red line adjacent to the black line, the idea being to see if the black and red line agreed. If they did, the production in question had been made at 100 per cent efficiency, that efficiency being based on the standards they had set for their production. The first operation of the chart shown had happened to agree very well. In the next operation the red line fell considerably below the black line, and throughout the rest of them, with four exceptions, were very equally all below the black line. The red ones which extended above were interesting to him, at least, because they showed that they were at this time getting a little better productive efficiency out of these particular operations than they had previously planned.

This particular type of chart of working ideas could be applied to an industry in general, where each factory produced an article, and giving a report to some central head, showing it was efficient, and how much of its capacity it was using and at what rate it was using that capacity; and with a given market and a certain definite product to be manufactured at a given time, it might be possible to so distribute the work that the most efficient man would get the work, and those who were not as efficient in that particular operation would have to swing over to some other operation they could be trained to do more efficiently.

W. C. Brinton thought that the slides which had been shown proved very nicely that in most executive work the problems involved practically every department that existed in most of the large corporations. He believed that, in the case of companies doing a business of $10,000,000 or more a year gross, or companies having a very complex problem of distribution, it was essential for the man who ran a chart department of that kind for the corporation to report to the man who was really running the corporation, no matter what his title was. In many cases the general manager ran the company, or the chairman of the board of directors, but the man who ran the chart department should be able to turn in unbiased reports and tell the actual truth, and bring it out so that the man in charge of the business could see it in all its details, and for that reason the man who ran the chart department should be protected by reporting to headquarters. He believed that money spent in running such a department would give a higher percentage of return than that of any other expenditure which the corporation could make.

According to H. V. R. Scheel, there had been presented for their consideration a principle which was a more fundamental thing than a discussion of ways and means. That principle was that we now had a definite measure of the efficiency of the management. We had broadened our consideration of where responsibility lay, consideration of the efficiency of the individual workman on a machine to a consideration of the efficiency of the whole, for which the management, particularly, had to accept responsibility. In other words, Mr. Gantt's paper showed a criticism of the management, but it was a constructive criticism, inasmuch as it presented itself in a way which enabled the management to correct errors, modify its plans, and lay out a course of procedure which would be more intelligent than any routine way of handling facts heretofore employed.

Written discussions of the two papers, from Messrs. Keppele Hall, Harrington Emerson, E. W. Bemis,[1] Stuart W. Webb,[2] and Henry P. Kendall, were read by the Secretary at this point of the session.

Mr. Hall thought it somewhat refreshing, in these days, when so much was heard about the efficiency of labor, to have emphasis laid on the efficiency of management. He believed that most management engineers would agree with him in the opinion that the vast majority of failures to succeed in business were due to the lack of what Mr. Gantt characterized as the "ability to do things" on the part of those really responsible, rather than to any other causes. One could well go a step further and state that in many instances a lack of real knowledge of the vital elements of operation precluded the exercise of this ability by those who really possessed it.

Industrial property, wrote Mr. Emerson, had, according to the point of view, three values: namely, the cost of its reproduction, the amount it would bring under the hammer, and its going value—the real value. This latter was difficult to determine, not because it was not possible on the basis of present

[1] City Hall Square Building, Chicago, Ill.
[2] Vice-President, Old Colony Trust Company, Boston, Mass.

or past returns, and with due allowance for a definite amortization, to convert net income into capitalized value, but because no one could see into the future far enough to set either any real valid amortization or to determine what next year's profits would justify as increased value.

In industrial concerns Mr. Emerson recommended constant reappraisals based on long average earnings. The valuation from month to month as well as the 10-year average, computed for each month, enabled him to estimate the tendency, thus varying the amortization or obsolescence provision.

If of two plants one was able to operate materials, labor and capital valuation at standard, and each combination of materials, men and capital was yielding the largest margin between cost and sales price, while in the other plant operation was below standard and without reference to difference between cost and sales price, the first plant might very easily have many times the value of the second plant, although inventories were identical.

Mr. Bemis thought that Mr. Gantt's paper did not have a large bearing on the work of the appraisal engineer in rate cases, for in these the attempt was to determine a fair value, which might be quite different from the value based on present rates and earnings. The productive efficiency should have some weight in rate cases; not, however, in determining the value of the property, but in leading commissions to allow a higher rate of return to a company of large productive efficiency, attributable to the excellence of the management, as compared with a business not so well managed.

In the opinion of Mr. Webb, from the operating point of view Mr. Gantt's suggestions regarding idleness expense were highly important. It did not seem to him, however, that this item, which he had usually heard referred to as "load factor," reflected very accurately the value of the plant, due to the fact that so many different things might cause a low load factor. While most of them would probably be due to poor management, there would be other factors, such as, for instance, a distinct change in style (over which the management would have absolutely no control), which might throw a plant that had been operating efficiently entirely out of balance. It seemed to him, therefore, essential to add to the elements of which Mr. Gantt spoke at the end of his paper, "demand for the product and relations to the market (good-will)."

Mr. Kendall wrote that at the Plimpton Press that part of the burden which was not earned through the continuous operating of all or any of the machines, was called unearned burden. If the plant ran its full equipment full time, it had a credit; otherwise there was a certain amount of unearned burden, which was deducted from the profit and loss for each department at the end of each four weeks. He thought that if the net book value of a plant were based on the actual net investment and actual earnings after allowing a proper return on net investment, and costs were determined on a basis of direct expense with only the pro rata per cent of burden applied regardless of whether the entire plant was operated or not, we would then have a common and standard way of determining these three points, which at the present time did not exist.

Oral discussion being then resumed, Robert B. Wolf said that he would like to call the attention of the members to the fact that Mr. Gantt had primarily made a strong plea for organization unity. The records exhibited formed a method of keeping track of the economic forces in the industry primarily for the purpose of enabling the management to have some record of their progress, and, as he had just quoted from Mr. Polakov's paper, the results produced in the plant depended on how these material forces were used; but unless these records of plant progress were furnished to the management, they could not possibly use these forces intelligently.

We heard a great deal about the efficiency of the workmen, and we were doing a great deal to make them more efficient, but were we giving to the management the necessary information to enable those in charge to become efficient? They were human as well as the workmen, but if we were going to humanize our industries and build men, we had not only to build men at the bottom, but men at the top. He thought that was primarily the keynote sounded in this plea by Mr. Gantt for a greater knowledge of the whole progress of the plant.

H. M. Wilcox stated that he desired to broaden one question, and that was in respect to the granting of industrial credits. They had been shown a way by which the efficiency of the management of an industrial plant could be measured periodically, and he could see very good reasons why the measure of the efficiency of an industrial plant, taken periodically, should be used as a basis for the extension of credit to that organization.

A PLAN FOR THE DISTRIBUTION OF PROFITS

William Kent thought that the whole question of the investment of capital and the returns which should be made upon it, the distribution of profits, had got to come up and be solved in the future, and he wished to offer an idea as to a probable solution. Suppose the Government should pass a law, which should be approved by the community at large, that in shipbuilding or in armor plate or in railroads, or in certain other things, public utilities, or industrial pursuits that had connection with the public—what might be called quasi-public utilities, there should be $1,000 issued in bonds for each $1,000 of capital stock, the latter being entitled to a six per cent dividend if earned, the former to 3 per cent interest. A company then should be allowed to earn, without any further investment, 5 per cent, to go into the treasury of the company, so that the company might be able to withstand extraordinary charges due to accidents or floods, etc., or due to having to compete with concerns employing superior machinery, necessitating the company to put in better machinery after awhile or go to pieces. Any excess earnings should be divided, one-half going to the stockholders and one-half to three different parties, the Government, the consumers (by lowering the price or rates), and the workmen who helped make the money.

After calling upon Vice-President James E. Sague to preside temporarily, Chairman Hess took the floor and stated that he did not quite agree that Mr. Gantt's paper was as broad as it apparently purported to be. It really was only a question of detail. It did not make any difference how costs were kept, whether one kept tab on the management, or on the day laborer. Essentially, the thing was to know the costs, no matter what the routine was, or who gave the costs, and after all was said and done the methods of determining these costs were probably as various as the people who were trying to find them out, and probably as various as the industries for which the costs were being kept.

F. J. Cole called attention to the fact that, while keeping all the machines going all the time was of course the economical way, a surplus of machines was sometimes required to take care of variations in product, where the character of the machine work varied considerably with different articles of the same general class which were being manufactured.

W. S. Rogers drew attention to two statements in Mr. Polakov's paper, and recited certain personal experiences by way of emphasizing their importance. The final test of good-will came to a concern when it had to borrow money. He had found that bankers, in investigating the right of a company to ask for loans, had not only desired facts regarding the work done, but also proof that the methods used were the best. They were asking what was the value of the methods, and Mr. Gantt had laid the foundation in detail to lead up to that.

Arthur C. Jackson hoped that some time Mr. Gantt would bring before and show the Society the necessity of charts for a whole industry, and select and define and portray on these charts the definite essentials for the economic operation of that industry, so that each member, each corporation within that industry, would have set up before it the beacons without which they were very apt to run upon the rocks. It seemed to him that this responsibility should lie on the engineering profession, and not, as had been the case in the past, on the lawyers or on the political economists.

The Secretary spoke of visiting recently the Birmingham plant of the U. S. Steel Corporation, and of how profoundly impressed he had been by the attention which the management gave to matters affecting the welfare of the workmen. He spoke also of the interest taken by workmen in production charts that he had witnessed not long ago in a large paper mill, and said that these two observations showed to him a way of tying in the excellent points which had been brought out in the papers: first, the human interest of the managers in the personal needs and health of the workmen, even to their housing conditions, and then, second, making the workmen co-partners in the management of the plant.

In closing the discussion of his paper, Mr. Polakov said that he desired to make but one statement. Admitting that the method of use of the investments and tools of production was the revenue-producing factor, the economic soundness of industry must be a broad criterion as to whether the production was carried out in such a way as to make the men idle and the commodity cheap. If we failed to accomplish either one of these things, we would ruin the country by producing things that could not be consumed, or would limit the production on account of the low purchasing capacity of the consumers.

Mr. Gantt, in closing, said that it was not pretended that his paper contained a complete solution of all our valuation or accounting problems, but it did point the way to detect many of the sources of waste and inefficiency which had heretofore been disregarded, and which could not be detected until we got a proper appreciation of values.

Among the discussions which were particularly significant he might single out that of Mr. William Kent, who seemed to be troubled about the difficulty of fixing a valuation for taxation purposes, if this method of valuation were accepted. This was particularly pleasing to him because, if the methods which were proposed did harmonize with the present system of taxation, he would feel very much discouraged, for there was nothing which was so detrimental to our industries and to prosperity in general as our system of taxation, by which the energy, initiative and business success of the individual were taxed for the benefit of the community, and the wealth created automatically by the community was allowed to go, without any return, to individuals who, as a rule, were contributing nothing to that community. If the wealth created automatically by the community should be claimed by the community, it was highly probable that it would be unnecessary to tax any of the industrial activities of individuals, and Mr. Kent's troubles would absolutely vanish. If the proposed system of accounting had a tendency to make that factor clear, it would do much to lift a burden from our industries and enhance the prosperity of the workers.

If we would meet the competition with which some of us thought we would be so direly threatened after the war, we must encourage industry and discourage idleness, for the warring nations, having found what an enormous increase in strength such a procedure had given them, would hardly return, when the war was ended, to the other method which we seemed to cherish so highly.

Arbitrary laws based on opinions inherited from a bygone age were not suited to an age like this, when the struggle for existence, which was so keen in Europe, threatened, perhaps in another form, to involve us; for the same causes that were active there were active here.

Ninety years ago Thomas Carlyle had said, "The tools to the hands that can wield them."

It was a reversal of this policy which more than all other causes combined had brought Europe to such dire extremity. The control of the implements of production had fallen into the hands of investors, who saw more profit in the control of markets than in productive efficiency, which they did not understand.

Competition for the control of markets was at bottom the primary cause of the great war, and the fact that Germany had had a somewhat clearer comprehension of the importance of productive efficiency and the necessity for the control of tools by the hands that could wield them, was the explanation of her tremendous industrial and military power.

During the last eighteen months England had revised her policy, and through her Minister of Munitions had taken industrial control from stock and bond holders and placed it in the hands of those who could "deliver the goods." The development she had made since this change was so phenomenal as to be almost unbelievable. In her attempt to save her life she had learned that strength lay in productive efficiency. The other European nations had undoubtedly learned the same fact.

In the face of these examples were we still going to pin our faith to market control, until aroused by a catastrophe, or could we learn from the fate of others and begin at once to develop productive efficiency? We had been talking efficiency in this country for over ten years, but so far the results had been lamentably small. This was not the fault of the workmen, for wherever we had had efficiency at the top we had had but little difficulty in training workmen to be efficient.

For years, with inefficiency at the top staring him in the face and hampering him at every turn, he had labored to find a means of measuring that efficiency, as it was perfectly evident that without efficient direction, efficient workmen were ineffective, even if it were possible to get them, which it usually was not.

If we could measure and evaluate the productive efficiency of the manager as we now measure that of the workman, we might hope for better results.

The only men organized for the promotion of productive efficiency were the engineers, and it was on their shoulders that must fall the burden of showing what could be done.

He offered as a part of this work the chart shown in his paper as an attempt to measure the efficiency of the executives, and to indicate in a general way their value, which we knew was an integral part of the value of any successful industrial property. This was only a first attempt, and he noted that already one engineer had taken a step beyond what he offered.

GAS POWER SESSION, THURSDAY AFTERNOON

THE Gas Power Session met on Thursday afternoon for the consideration of a program of papers arranged by the Sub-Committee on Gas Power, of which H. J. Freyn is chairman. Mr. Freyn was unable to be present and Prof. William T. Magruder conducted an exceedingly well-ordered meeting. The attendance was upwards of 150, and the papers were of such interest that the session continued until 5:30. Mr. Freyn sent the following telegram to the acting chairman:

"Regretting deeply inability to be present, am sending my best wishes for a successful session, with many thanks to yourself and greetings to all."

O. C. Berry[1] presented the first paper, on A Gas Producer for Bituminous Fuel, pointing out the essential features of a producer designed and experimented upon by himself. The paper was the subject of considerable oral discussion.

Because of its tar content, the author contended that bituminous coal could not be used in a standard updraft producer like anthracite. As even more satisfactory than either a downdraft or double-zone producer, he described a recirculating producer, discharging its gas near the middle of its height and returning the products of distillation above this point to the combustion zone at the bottom. The steam which must be supplied for the gasification process was introduced through a steam-jet blower and provided the means of circulating the gases.

A second line of investigation was to determine the proper temperature for the recirculated gases to precipitate the least tar, and between 300 and 450 deg. cent. (550 to 900 deg. fahr.) was found to be the preferred range.

The remainder of the paper described the recirculating producer designed by the author, an account of which appeared in The Journal for December.

DISCUSSION OF MR. BERRY'S PAPER ON A GAS PRODUCER FOR BITUMINOUS FUEL

In a written communication, Godfrey M. S. Tait said that the methods for the determination of the tar content were all highly practical as applied to the experimental apparatus used, but would have to be modified in connection with the test of a plant in regular service.

He said that the theory as to the volume of the recirculated gas was not original, having been tried with more or less success in Europe. The main difficulty was with the power consumed by the blower and the excessive quantity of steam thus introduced, unless some arrangement were provided whereby the governor of the engine might control the supply of steam.

The findings as to clinkers were apt to be misleading, due to the very small size of the producer. Any arrangement to get away from the balanced draft condition greatly increased the tendency to clinker in all kinds of fuels. The clinker was first formed by a fissure in the fuel bed through which there was a concentration of draft. A large fuel bed and grates that insured an equal distribution of the draft current to all parts of the fuel was the only way to prevent clinkers.

In practice, it would be found that the resultant increase in efficiency due to the fixation of the tarry vapors of the gas rather than to wash them out and waste them, was much less than would be expected.

Personally, he leaned to the construction of bituminous producers along the line of the simple single-zone up-draft type with attached tar washers as being better adapted to the hard usage of practice.

As to the reduction of CO_2 to 2CO, Mr. Tait's experience indicated that a perfect reduction occurred at 1800 deg. fahr. provided that the draft velocity was sufficiently low to allow the time necessary for the reaction.

He thought Mr. Berry should continue the investigation under conditions entailing more commercial conditions, variable load without special attention, and noting the possibility of keeping the gas tar-free during such variations without attention, the effect of large areas of the grate, etc.

In an oral discussion, Edward Rathbun said that while Mr. Berry's investigation appeared to be an excellent laboratory development, the actual gain in practical knowledge, as an aid to present commercial operation of producers, was somewhat limited. He called attention to Mr. Berry's statement that the gas was "nearly as clean as anthracite gas," and said that in order to develop the producer-gas engine, the gas must be clean, and that gas nearly as clean as anthracite was not clean enough.

Mr. Rathbun pointed out that in breaking up the methanes, the heating value of the resulting gas was low and that the capacity of the engine of a given bore and stroke was thus reduced and the flexibility of operation desired was not obtained.

Without question, said Harry F. Smith in discussing Mr. Berry's paper, the complete oxidation of the hydrocarbon content of the coal, the water vapor and the carbon dioxide, and the subsequent dissociation of these fixed gases and the carbon, constitutes an absolutely effective way of eliminating tar.

He pointed out that unless a coal contained a high percentage of fixed carbon there was not enough fixed carbon in the coal to carry on a recirculating process continuously in a producer. If the producer was running for several hours with sufficient stand-by periods, enough coke would be formed during these periods to cover the deficiency in carbon. One way to overcome the difficulty was to permit part of the products of combustion to pass out of the producer undecomposed, with a consequent loss in efficiency.

The objection to low heating value, mentioned by Mr. Rathbun, was of even more importance if the gas was used for industrial operations, such as brazing and forging. Since there were several methods available for cleaning producer gas, the removal of the tar was so easy and effective and the apparatus so simple that the justification of a more complex producer with the uncertainties of the process was questionable.

A uniform gas from soft coal was difficult to obtain, W. B. Chapman said in discussing the Berry paper. In his experience covering a period of twelve years Mr. Chapman had met with all the difficulties mentioned by Mr. Berry and more, and was not sure, in his own mind, that the problem of obtaining a gas from soft coal, suitable for gas engines, could be solved along the lines outlined in Mr. Berry's paper. The fuel bed of the Berry producer was too deep for easy poking, a disadvantage in practical operation. Unless there was some means of controlling the circulation of gas when the engine was under a light load, the fire would grow cold because of the returning gases.

In his oral closure, Mr. Berry referred Mr. Tait to the determinations of the United States Geological Survey in the

[1] Purdue University, Lafayette, Ind.

matter of the temperature necessary in practice for the decomposition of carbon dioxide. He explained that in testing the gas for tar, the gas was made to impinge upon a card, any tar in it showing a dark mark upon the surface of the card.

The gas was probably not all burned in the bottom of the producer, but it must be evenly distributed over the area at the bottom in order not to form cold paths between the grate and gas outlet. The gases could be cracked very effectively by passing through an incandescent zone, and, under a light engine load, the gases were simply cracked and the carbon monoxide passed through without being turned into carbon dioxide and then into carbon monoxide again.

The plant as operated ran ten hours a day under full load, was not operating at night, and was started the next morning after twenty-five to thirty minutes' blowing. It was never run for ten hours consecutively for more than a week.

MR. SWAIN DISCUSSES THE COMMERCIAL SAMPLING OF PRODUCER GAS

Philip W. Swain read an abstract of his paper on The Commercial Sampling of Producer Gas. He said that, as a rule, the sample of producer gas to be analyzed should be drawn from a pipe in which there was a continuous flow of fresh gas from the main. For a correct continuous sample, a number of conditions must be observed: namely,

a There must be no variation in pressure in the gas entering the sampling bottle

b The sampling pipe must draw from the main a sample representing the average gas over the entire cross-section of the main

c The sample should be drawn at a rate proportional to the flow of gas in the main. If the variations are not great, a sample drawn at a constant rate will approximate closely the correct sample.

Although a very good snap sample could be drawn using the ordinary two-bottle method of sampling, this method could not be used very well for proportional sampling, and was not reliable even for uniform sampling. The author described and illustrated a device which he had designed and used, and which permitted the accurate measurement and control of the flow of water from the sampling bottle.

There were several portable instruments on the market, modifications of the Orsat apparatus, which had means of determining not only the carbon dioxide, oxygen and carbon monoxide, but also the hydrogen, methane, and sometimes illuminants as well. In such instruments, the hydrogen and methane were usually determined by explosion with air. To avoid the various difficulties of determining carbon monoxide by absorption, the carbon monoxide might be determined by explosion with the hydrogen and methane. This involved a little more computation, but the labor might be minimized by standardizing the method and making use of a diagram which the writer had prepared.

Lack of interest in gas analysis, said W. E. Renling[1] in a written discussion, doubtless came from two causes: first, failure fully to appreciate the fact that a gas analysis, when properly interpreted, furnished a splendid check on the efficiency of the plant for the conditions under which it was being worked; and, second, from a rather inherent feeling that the subject of gas analysis was rather too technical, or savored too much of the chemical laboratory, to be really a friend and working tool for the practical engineer, owner or operator. It would be only through broader education and discussion that fuller appreciation would be given this subject.

It was the opinion of H. F. Smith that everything the author had said meant something to the fellow who had been up against the practical side of this work. However, he wanted to caution against the general statement that a good idea of the quality of the gas might usually be obtained from the carbon dioxide alone, to emphasize which he read from a number of analyses made by the same chemist, in the same plant, by the same method, and on gas from the same coal. The extreme variation in the carbon dioxide content, percentage of combustible and heating value gave evidence to show "that it is not always possible to depend on the carbon dioxide indication alone."

In his oral closure, Mr. Swain pointed out that there was considerable difference of opinion among men with wide practical experience as regards carbon dioxide as an index of gas quality, some being so certain that it was an indication of gas quality that only carbon-dioxide determinations were made by them.

In answer to a question by S. A. Moss, Mr. Swain said that it was quite important to have the velocity of the gas in the sampling tube the same as that in the main pipe if the dust or suspended matter in the gas was to be determined; but as the analysis was of a fixed gas which had passed through a scrubber and presumably was well mixed, there seemed to be no necessity for sampling at the exact velocity of the gas in the main. The idea was to take a sample continuously, and to take it at all times in proportion to the rate of flow of gas through the main, so that the final sample would be the same as though all the gas had been drawn off and then a sample obtained from it.

PROFESSOR EARHART TREATS OF CERTAIN NATURAL GAS PROBLEMS

The next paper in order was on The Ratio of the Specific Heats and the Coefficient of Viscosity of Natural Gas from Typical Gas Fields, by Robert F. Earhart. An abstract of this paper appeared in the November, 1916, Journal, to which the reader is referred.

In a written communication upon this paper, Harold B. Bernard said that, due to the many features encountered in piping natural gas, such as condition of pipe, type of joints, bends, temperature changes, etc., it was doubtful whether Professor Earhart's determinations were of value outside the laboratory. For practical conditions, the formulae derived by T. R. Weymouth[1] from numerous observations were unquestionably of sufficient accuracy for problems involving the flow of natural gas.

A recomputation of densities of the author's Table 1 was also given. The new densities were computed from the fact that the densities were as the squares of the relative coefficients of viscosity, the coefficients of viscosity being in the ratio of the times of efflux. It is expected to give later publication to this table.

P. F. Walker, in a written discussion, said that paper was an interesting illustration of the application of scientific methods of analysis to technical problems. It was a variation from the methods which were commonly employed in the discussion of engineering problems, and it was a significant thing that work upon which the engineer was now engaged was being treated in many lines with a degree of accuracy

[1] M. E. Dept., Michigan Agri. College, Lansing, Mich.

[1] Trans. Am.Soc.M.E., vol. 34, p. 1091.

which made possible, if not necessary, the employment of the refined apparatus of the physicist.

The author used in his title the words "ratio of specific heats," and throughout his discussion showed that he was assuming that this ratio and the value of the adiabatic exponent were identities. It was here that the trouble would begin. It was not necessary to go through the steps of the mathematical proof of the principle that for a perfect gas the adiabatic exponent was the ratio of the specific heats. It had been his observation on several occasions, however, that it was necessary to remind engineers of the fact that the statement applied only to perfect gases. It seemed to be ingrained in the minds of technical and scientific men that the adiabatic exponent must be the ratio of the specific heats. The point brought out in the previous paper by the author, and in substance fully attested to by all who took part in the discussion, was that this gas in its behavior did vary materially from the laws of perfect gases, and hence it must follow that the value of the exponent found for an adiabatic cannot be taken as the ratio of specific heats.

W. D. Ennis opened the oral discussion by stating that while the value of n for the adiabatic curve might be determined from compressor indicator diagrams, no engineer believed that this was the ratio of specific heats. He also pointed out that there must be some error in the author's determination of n, as in some cases it is less than the value of n for any of the constituents of the gas.

As to the author's method of procedure, there seemed to be nothing wrong, except that the determination of n for the gas as a function of that for air by comparing the wave lengths would have seemed more conclusive if the apparatus had been tried out on some other gas, such as carbon dioxide, for which the value of n was known.

Sanford A. Moss showed that the value of n could be computed from the gas analysis from the expression

$$n = \frac{X_1 C_{p_1} + X_2 C_{p_2} + \text{etc.}}{X_1 C_{v_1} + X_2 C_{v_2} + \text{etc.}}$$

Commenting upon the written discussion offered by H. B. Bernard that the densities are proportional to the squares of the times of efflux, Edgar Buckingham said that the statement is at the bottom of Bunsen's method of determining the relative densities of gases by means of efflux through small orifices. The statement was not theoretically correct nor did it give correct values in practice. Bunsen's method is an approximate, not an accurate one, and his own determinations are correct only within five or ten per cent.

As the author was not present, it will be necessary to defer the publication of his closure.

POTTER AND BUCK'S TESTS OF GAS AND OIL ENGINES USED ON TRACTION ENGINES

Also, the authors of the next paper, A. A. Potter and W. A. Buck,[1] were unable to be present. This paper was upon An Investigation of the Internal-Combustion Engine as Applied Traction Engines, which was instituted to determine fuel economy and thermal efficiency of different types of motors used in traction engines. The following conclusions were derived:

Four-cylinder motors were better adapted to belt work; single-cylinder and two-cylinder motors operated better than four-cylinder motors with fuels heavier than gasoline.

Piston speeds should be lower than in automobile motors, speeds of from 700 to 900 ft. per min. giving satisfaction.

The valve-in-the-head type of motor had the more efficient combustion space and was to be preferred to the T-head or L-head types.

The jump-spark system of ignition was to be preferred on account of its mechanical simplicity.

The fuel-economy range was from about 1.3 lb. per b.hp. per hour at one-fourth load to about 0.7 lb. per hour at full load. The fuel consumption in pounds per hour per brake horsepower was very nearly the same for both gasoline and kerosene.

The thermal efficiencies at full load varied from 14.88 to 19.41 per cent for gasoline fuel, and from 13.7 to 15.97 per cent for kerosene.

Carburetors now used are satisfactory for gasoline, but a carburetor jacketed with heat from exhaust gases should be employed when operating with kerosene or with heavier fuels.

The results of the tests show the advantages of kerosene as a fuel. For a group of motors developing 26 b.hp. and under, at full load, with kerosene at 10 cents per gal. and gasoline at 20 cents, the cost of operating with gasoline was 1.99 times that when kerosene was used. Similarly, for a group developing 51 b.hp. and over, at full load, the cost with gasoline was 1.62 times that with kerosene. The advantages of the kerosene-burning motor were somewhat offset, however, by the added trouble in handling and by the shorter life of the motor when operating on such fuel.

W. D. Ennis said that he was particularly interested in the reported economy of the engines tested, which averaged not far from 0.8 lb. This was a strikingly favorable figure as compared with the hot-cap engines of the semi-Diesel type in which liquid fuel was injected as a liquid into the cylinders. These hot-cap engines, at about 50 lb. compression, used about 0.9 lb. of kerosene per b.hp-hr., and just about the same amount of fuel oil of the usual Eastern grade. It was an interesting question whether the extraordinary economy of the carburetor type of engine as presented in the paper, was due to a higher compression than 50 lb. or to better combustion. He said that he did not believe it would be generally admitted that with equal compression and the same fuels the hot-cap engine was inferior in economy to the engine of the carburetor type.

The program concluded with an Illustrated Review of the Development of the Werkspoor Marine Diesel Engine, by Thomas O. Lisle. This has not yet been published in The Journal, but it is planned to give later a comprehensive account of the lecture, with illustrations selected from those used for the lantern slides.

In answer to a question by A. J. Wood, about the relative weights of two- and four-cycle marine Diesel engines, Mr. Lisle said: "It has been found in marine work that the four-cycle engine is rather lighter, owing to the extra parts necessary for the two-cycle, particularly the scavenging pump. Theoretically, the two-cycle should be much lighter, but of all that have been put into service, the two-cycle have been heavier than the four-cycle."

Julius Kuttner[1] asked about the strength of the reversible propeller used on some Werkspoor boats, and was answered that the strength was a matter of design.

---

[1] Asst. in Steam and Gas Engrg., Kan. State Agri. College.

[1] 567 West 113th St., New York City.

MISCELLANEOUS SESSION, FRIDAY MORNING

AT the general session on Friday morning an address of absorbing interest was delivered by Wm. L. Cathcart[1] on the Development of Our Fleet and Naval Stations. This was illustrated with lantern slides showing vividly the needs of our navy, particularly with respect to naval stations and naval bases, and was supplemented by a general discussion to which valuable contributions were made by Rear-Admirals John R. Edwards and Bradley A. Fiske; and by President D. S. Jacobus and President-Elect Ira N. Hollis. It is expected that the address and discussion will constitute a leading feature of the February issue of The Journal.

MR. CATHCART SOUNDS NATIONAL NOTE ON COUNTRY'S NAVAL NEEDS

Mr. Cathcart said that the elements of naval strength are its ships and men and its shore stations; he showed by means of diagrams how important are naval bases for the protection of our vulnerable coast; and how the location of such bases and naval stations on our own coast with respect to our possible battle grounds of the future are of primary importance. For the maintenance of our navy we needed a large number of navy yards with channels of approach dredged to full depth and with modern equipment for building both hulls and machinery. Reliance must be placed both on mines and submarines for the protection of our harbors, which in turn must be protected by shore batteries or the guns of a fleet.

Mr. Cathcart discussed certain features of interest alike to artillery officers and engineers, such as modern battle ranges, with comparison between the effectiveness of 14-in. and 16-in. guns; fire-control methods, the foundation of which was the successful application of the telescopic sight to naval guns; the possibilities of modern guns and powders, and the degree of excellence of marksmanship in our navy.

He contended that the navy should not be for aggression but to keep peace and to exert what Mahan called the "silent force of sea power," for which a large navy would be needed.

The address made a deep impression upon those present and there was a general feeling of approval and a very evident responsiveness to the convincing presentation by Mr. Cathcart of the nation's needs.

Rear-Admiral John R. Edwards[2] stated that the author's paper was one of the strongest he had heard in the last decade. In view of the fact that he had served as General Inspector of Machinery for the United States for all machinery built on the North Atlantic Coast, he was familiar with every shipyard and with the various shore stations on this coast. He therefore dwelt on the needs of these stations and gave constructive suggestions for their further equipment, of which they are so much in need.

He said that if were were to construct ships we must have facilities for repairing them. There must be docks large enough to take modern men-of-war, cranes heavy enough to lift the immense guns or the turrets off from a ship; deep piers at least 100 ft. wide; dry docks 1000 ft. long; and other equipment in proportion, not forgetting the need for hospitals and dispensaries.

Taking Charleston's harbor as an illustration, the thought was preëminent in his mind that we could allot without reservation the value of either one battleship, battle cruiser, two scouts, or ten destroyers, if necessary, in order to build a modern station at that point. The other countries of the world would measure our strength not alone in battleships but in our facilities to build battleships and to repair and equip them.

The history of Gallipoli and Salonica showed that there must be miles of water front in order to move a modern army, as a result of which the naval engineers of France and England were building large naval piers sufficient to accommodate 50 transports at one time. The need for such piers applies to both distant bases and to those at home, including the base at the Canal Zone.

He reviewed what England had done through the past five years in upbuilding its naval stations, beginning at the Firth of Forth, and what Germany had done at Wilhelmshaven and Heligoland; work of vast extent and of tremendous scope which had many times proved its worth since the beginning of hostilities. These developments certainly constituted a striking object lesson to American naval officers and engineers.

Rear-Admiral Bradley A. Fiske said it was unfortunate that the people of our country did not realize the danger to which they will be subjected when the nations at war agree on terms of peace and arrange what they will do in order to overcome the financial disaster which is threatening them. The people in our country at large believed there was no danger, and were ignorant as to what might be required to insure the safety of the country. It was the duty of every member of the Society to use his power and influence among his associates and acquaintances to show them, by the aid of the accurate thought and language to which engineers are accustomed, what the actual danger was and what the requirements were for national defence.

Dr. D. S. Jacobus emphasized the duty of the engineer to enter into public affairs. He should take more interest and do more in performing his civic and governmental duties. The attitude of the Society has been that it should not undertake anything except strictly engineering work, but times are changing, and we should consider whether the Society should go further than this. Possibly it would be better for engineers from different societies to combine for the purpose of dealing with important public matters and show what engineers can do through coöperation, something after the order of the work done in connection with the industrial census. He felt that the day is not far distant when either through the action of the existing societies or through some other organization engineers will take their true place in the management of affairs.

Prof. M. E. Cooley, speaking from the standpoint of an educator, said that the impression existed that the Naval Academy was the only institution which fitted a young man for naval service, and West Point the only institution fitting for military service. He had recently had occasion to compare the curriculum of the Engineering College of the University of Michigan with that at Annapolis and also at West Point respecting the highly specialized training of military character obtained in both of these institutions, and which, of course, was very essential. He found that the curriculum of his engineering school paralleled about 85 per cent, or possibly more, of what was given at Annapolis and West Point. In other words, by adding about one-half year more of work or by substituting one-half year's work in place of other subjects, young men could be turned out from our engineering colleges with the same general training with which they were now trained at either Annapolis or West Point.

[1] 636 Westview Ave., Germantown, Philadelphia.
[2] Bristol, R. I.

Dr. Ira N. Hollis referred to the participation of the Society in public affairs and said that he not only approved of it but thought that the continuation of the organization as a useful function of society was absolutely in that direction.

There had been a great deal of interest in the United States in preparation for war, or military preparedness; but he looked upon preparedness as a very much larger matter. He would strengthen the conception of service by leaving out the word "military" and extend the work of preparedness to all public and private affairs that are in any way related to the larger success of the nation.

A friend in command of one of the large naval stations had written suggesting that civilians ought to serve for a short time every year as understudies in the conduct of naval manufacture and repairs, so that men would be trained during peace to take charge of the work in time of war, thus relieving officers who were prepared in the more technical details. That illustrated the direction in which we should work and suggested the organization of an Engineers' Reserve composed of members of our Society for all purposes behind the fleets in making the supplies for the Navy and in training for war service.

Was it not a duty of every young man to give, freely, one, two or three years of service to his country, no matter whether that service took the shape of learning how to fire a gun or going into public service for the purpose of building ways of communication between the different parts of the country?

Any young man should feel proud to serve on a Lincoln Highway after enough experience at Plattsburg to teach him obedience and the democracy of the barracks. Two years' digging for his country, as a free contribution towards means of communication, would be as important for peace as for war. The pick and shovel could be made as effective in promoting love of country as the rifle, and every youth ought to have a taste of them.

Brief remarks upon Mr. Catheart's paper were made also by Carl G. Barth, M. A. Stone and F. G. Coburn.

MR. COBURN DESCRIBES NAVY METHODS OF HEAT-TREATING WROUGHT-IRON CHAIN CABLE

Following the presentation and discussion of the paper on naval preparedness, a brief abstract was presented by Fredk. G. Coburn,[1] of an important paper on Heat Treatment of Wrought-Iron Chain Cables, prepared jointly by Messrs. Coburn, W. W. Webster and E. L. Patch.

All the chain cable for the U. S. Navy is made in the smith shop of the U. S. Navy Yard at Boston under the direction of Naval Constructor Coburn. This chain was formerly hand-forged, but it was finally decided to adopt power forging, after which considerable difficulty was experienced through the frequent failure of the chain links. It was evident that some form of heat treatment was necessary, and as there was practically no information available on the heat treatment of wrought iron, which was used in the manufacture of the chains, an extensive investigation was conducted. It was found that annealing under certain conditions relieved the stiffness which apparently existed in the links and to which their failure was attributed.

Preliminary to the tests upon the links themselves, tests were conducted upon the material used in the manufacture of the chain, in the way of chemical analyses, tensile and impact tests and metallographic examination.

The paper gives the results of these several series of tests, a summary of which will appear in an earlier issue of The Journal.

[1] Boston Navy Yard.

STEAM BOILER SESSION, FRIDAY MORNING

A LONG and highly profitable session was held on Friday morning under the auspices of the Boiler Code Committee. The audience, though small at first, grew in size until at last it taxed the seating capacity of the room. At the request of John A. Stevens, Chairman of the Boiler Code Committee, Professor A. M. Greene, Jr., acted as presiding officer, assisted by Sherwood F. Jeter. In addition to the three scheduled papers, two topical discussions were presented upon the subject of welding.

The first paper, upon An Analysis of Marine Safety Valves, with Suggestions for Repairs and Improvements, by E. F. Maas, considered the various elements of safety valves which had to do with the successful operation of the valve. Seven typical valves were discussed with respect to the following points: Tightness; pop of valve and simmering; lift of valve; closure and chattering; blow-down and its adjustment; discharge capacity; repair and adjustment.

The author believed the flat-seat valve superior to the beveled-seat valve, contending that it was as easy to grind and would more generally remain tight. He showed how certain valves provided with adjustable blow-down might be rebuilt so that when repaired the necessary machining would be small and need not be done to a standard gage. The paper contained many suggestions of practical value for the grinding and repair of safety valves.

Charles W. Barnaby opened the oral discussion of the Maas paper by asking why all manufacturers of safety valves used a square rod for valve springs when it had been discarded for springs for practically all other purposes.

A. A. Cary answered Mr. Barnaby's question by saying that it was possible with the square-rod spring to get more resistance in a given volume. The round spring was theoretically the best. The principal resistance was to torsional movement. The square spring occupied less space, was more rigid, and better adapted for pop valves in every way. It held its shape, and manufacturers who had used round wire and bar springs always came back to the square springs.

MR. TALBOT DESCRIBES HIS MARINE TYPE OF BOILER WITH FORCED CONTRA-FLOW CIRCULATION

Assisted by lantern slides with which to illustrate his paper, Paul A. Talbot[1] gave a descriptive talk upon the boiler which bears his name. This boiler utilizes the principle of forced contra-flow circulation through water tubes at high velocity. Steam drum and water drum are unnecessary, so that danger from explosion is reduced to a minimum. Oil is sprayed by superheated steam into the combustion chamber, which is lined on all sides with heating surface.

The supply of feed water passes through a regulator valve before entering the boiler. This valve is controlled by the expansion of one of the tubes of the boiler so that it opens and closes with varying temperatures of the steam within the tube.

[1] Pres., Talbot Boiler Co., New York City.

The fuel valve is also controlled by the expansion of this same tube so that the fuel supply is cut off if the temperature of the steam becomes greater than is desired. The control of feed and fire thus becomes automatic. A gage is provided for indicating to the operator the relative temperature of the steam.

The high velocity of water and steam over the heating surface prevents the formation of scale. Steam jets are provided for blowing soot from the outside of the tubes.

A high rate of evaporation is obtained, the average, including economizer and superheater surface, being 8 lb. of water per sq. ft. (16 lb. on forced draft).

Because of the contra-flow principle, the effect of increased draft and higher evaporative rates is to increase the economizer surface of the upper tubes and to modify the stack temperature.

In a written discussion, Albert A. Cary commented upon the similarity in construction of the Talbot boiler and the Niclausse boiler, which had the same field tube arrangement. His personal experience had taught him the desirability of having the water storage made a part of the boiler, which provided to a certain extent an immediate source of water supply, when the combustion in the furnace was quickly increased to meet a sudden demand for steam. The tendency of many inventors in producing compact water-tube boilers, especially those of the marine type, had been either to reduce greatly the size of their steam and water drums, or else to do away with them altogether; and it was still an open question as to how far this could be safely and rationally done. In the Talbot boiler, automatic regulating devices did away with water storage.

While the Talbot boiler did not better the Niclausse boiler in exaporative rate, it required considerably less space per unit.

His experience did not lead him to believe that there was solid water within all the tubes of the Talbot boiler when it was in operation. Tests made in England on the Belleville boiler, of somewhat similar tube arrangement and forced water circulation, had shown that 50 per cent of the boiler under normal conditions was filled with steam. Judging from this, it was safe to assume that a considerable lower portion of the Talbot boiler was filled with steam during operation, and such steam-bathed surfaces could hardly be considered good water-contact heating surfaces, i.e., efficient for the production of steam.

He believed in the contraflow principle in operating boilers, providing it could be accomplished by simple means and without too great an expenditure, or inaccessible moving parts.

Extended experience had taught him that the highest results for heat transmission in boilers were secured by removing the steam from the heating surfaces almost as rapidly as it was formed, and thereby permitting the greatest possible area within such heating surface to be bathed and wetted with solid water. In this type of boiler, which prevented the steam formed in the interior of the boiler from escaping from the heating surface, we were certainly not improving the conditions required to facilitate rapid heat transmission through the lower and most valuable area of the heating surface.

The danger of scale in a boiler equipped with field tubes was brought out by Mr. Cary, who said that although there might be a sufficiently high velocity to prevent scaling when the boiler was in operation, there were periods when the boiler would be shut down and when the scale might accumulate so persistently that the circulation of the water, upon resumption of operation, would not be sufficient to remove it.

Capt. C. A. Carr, U.S.N., said that the first tests of the Talbot boiler for the navy showed particularly good results in the reduction of the quantity of oil burned and the increase in speed of the boat. It was believed that in this case the economy was caused directly by furnishing dry or superheated steam to an engine which previously had been very wasteful through the use of wet steam. The use of the Talbot boiler appeared to furnish a ready, reliable, convenient and inexpensive means of supplying steam of any desired degree of superheat for small power installations in which oil was used as fuel.

Perfect control of the feed system for this type of boiler was essential. On account of the small reserve capacity of steam and the friction of steam and water in the boiler, the feed pumps usually furnished with small marine plants would be found unsatisfactory. The automatic control valves were intended for use when the engines were running steadily. When working to bell signal, the oil supply and feed valves were necessarily regulated by hand.

Captain Carr considered the oil-burning system furnished with the Talbot boiler unsuitable for large boilers and wasteful of both oil and steam with small ones.

Prof. R. C. Carpenter said that a study of the White boiler plant in connection with the Talbot boiler should prove of interest. He made reference to a paper which he presented in December, 1906, and which appears in Vol. 28 of the Society's Transactions, dealing with his tests of the White automobile boiler.

John W. Parker spoke of the difficulties he had experienced with his early investigations of boilers of the general type of the Talbot boiler, particularly with the scale formed by the insolubles in the boiler water. He showed how Belleville, who attempted for a long time to build a water-tube boiler without any drum, finally installed the drum, later introducing a gravity circulation independent of the pump, and at last succeded through perfected automatic control devices. If the Talbot boiler succeeds, he believed it would depend on the efficiency of the automatic devices for its success.

In his oral closure, Paul A. Talbot pointed out that the particular advantage of the field-tube construction was the relieving of the strains due to the expansion of tubes between tube sheets. He showed that in the tubes in his boilers, the expansion under a temperature of 800 deg. fahr. was as great as one-half an inch. The high velocity of circulation under extreme firing conditions, he said, keeps the boiler cool.

Speaking of the deposits in the boiler tubes, Mr. Talbot stated that even with the water of Puget Sound in the boilers there was no accumulation of scale in the tubes. After standing all night, there was a small amount of silt in the tubes, but this was swept away as soon as circulation was set up. The high velocities would damage by erosion, rather than corrosion. There was never any formation of sediment noted when the tubes were examined after the boiler had been shut down.

In answer to a question put by D. K. Warner[1] about limiting the draft to two inches, Mr. Talbot said that two inches was not a limit. Lack of time and money have prevented experiments with forced draft.

The tube referred to in the original paper which was removed in 61 sec. was chosen at random by the officers in charge of the test as the one they wished changed. All of the tubes were accessible, but it was not possible always to change a tube in as short a space of time as this.

[1] Sheffield Scientific School, New Haven, Conn. Graduate Student.

Sherwood F. Jeter was answered that the change in the construction of the header was made because it simplified the construction and for no reason which affects the operation of the boiler. (This change in construction was illustrated in one of Mr. Talbot's slides and did not appear in the illustrations accompanying the original paper. It referred to the cored passages of the header.)

MR. PARKER OUTLINES THE DEVELOPMENT OF HIS DOWNFLOW TYPE OF STEAM BOILER

The downflow type of steam boiler was discussed at length by John Clinton Parker in a paper bearing that title. With the aid of lantern slides, Mr. Parker presented an interesting lecture.

This paper describes the early experiments which demonstrated the possibility of circulating the water in boilers apparently contrary to the natural way, that is, downward rather than upward. From these there was developed the downflow boiler which was designed and had been built by the author for a number of years.

Among the advantages of the downflow principle was the fact that the course of the water and steam were opposite to those of the flame and hot gases, consequently the hottest particles of each were in communication with the hottest particles of the other and there was a minimum difference of temperature between the adjacent particles of the two.

The tubes are formed, by connecting their ends together through junction boxes, into a number of vertical coils, and one of the special problems of the manufacture of this boiler was the design of these junction boxes. The paper described these boxes, which were constructed of malleable iron.

A. A. Cary opened the oral discussion by making objection to the location of the superheater in the Parker boiler, which was placed in the combustion chamber near the bridge wall. The superheater, he said, was a secondary apparatus, and after the boiler had absorbed all the heat possible, the waste gases were led away to superheat the steam. In this way, one did not deprive the boiler of any of its functions. He also pointed out that the efficiencies obtained with the Western coals in the St. Louis tests, quoted by Mr. Parker, were not as high as would be obtained with Eastern coals.

In his closure, Mr. Parker cited Rankine as his authority for placing the superheater. He deprecated efforts of manufacturers to establish exceptional boiler performance under conditions not readily obtained in practice, and stated that he had made it a rule to compare his boiler with others under ordinary working conditions.

MR. WILDT DESCRIBES THE PENCIL ELECTRODE METHOD OF WELDING

E. A. Wildt[1] gave an illustrated talk dealing with The Pencil Electrode Method of Welding. The manuscript was received too late to appear on the program, but was presented at the request of the Boiler Code Committee in order that this important subject might receive a general discussion.

The object of the paper was to educate engineers on the matter of welding, by a description of the pencil electrode method which was used for boiler joints. The author wished the Society to consider whether it was more feasible to weld the joints of a boiler drum than to rivet them with a butt strap joint.

The success of any weld depended upon bringing the pieces of metal to the proper heat. Electricity was used only to supply the heat, and in the pencil method only just enough heat was obtained to accomplish the joining of the two metals. Regardless of whether the voltage or the amperage were uniform, a metal wire used as part of the circuit always formed one terminal and provided the welding metal.

The temperatures obtained in gaseous and electric-carbon welding wherein fluidity of both metals was a condition, were 2800 to 3000 deg. fahr., while in the electric-pencil method the temperature did not rise much more than 1500 deg. fahr., which was only enough to produce a plastic condition.

The forge welding, approved by the A.S.M.E. Boiler Code, caused heavy expansion strains, so that when the forge-welded seam had cooled off, the adjacent expanded metal produced tensile strains tending to pull the welded portions apart. The pencil electrode and the forge method were alike in the fact that in neither was the metal heated beyond a point necessary to produce a weld. That which prevented the high temperature in the weld was the fact that as fast as the metal to be added to the weld became plastic, the pencil must be advanced toward the work to close up the spark gap, the current otherwise being interrupted. Failure on the part of the attendant to keep this gap the proper size at all times resulted in the frequent extinguishing of the arc. The heat being confined to the smallest area, the expansion and contraction strains were small.

Welds made by this method were feasible for pressures of 500 lb. per sq. in. with half-inch plates, as had been demonstrated by experiment.

The metal of the weld could be controlled by the kind of metal that was added. The weld was made thicker than the original plate to be sure of strength.

There was at the present time a small water-tube boiler of the vertical two-drum type in service. All the tubes were bent and there was not a rivet in the drums.

A written discussion of Mr. Wildt's paper was presented by P. A. E. Armstrong,[1] and illustrated with lantern slides. The superiority of electric welding over gas or fire welding, Mr. Armstrong said, was due to the extremely localized character of the heat generated by the electric arc, thereby resulting in a smaller area of thermal disturbance.

While the electric carbon arc had a tendency to heat the metal almost as much as the gas process, the bare-wire electric process restricted the thermal disturbance in a large measure. The deposited metal, however, was usually oxidized and distinctly cold-short, therefore having almost a complete absence of ductility. The problem was to surround the bare wire with a substance such as the slag which formed when steel was made in order to protect the metal of the weld from the evils of oxidation. Such a means was employed in an electrode recently developed in Great Britain.

The special electrode was composed of an iron or steel core. Running parallel to its axis was a very thin aluminum wire, its purpose being to purify the melt, and covering its entire length was a braided slag. The current passed through the core. The slagged end of the electrode was brought in contact with the job to be welded and an arc formed which had the effect of fusing the core and the covering slag. The atmospheric arc was extinguished and a quasi arc of vaporous slag took place. The molten metal flowed out at the end of the electrode upon the work and was at all times covered with a large body of protecting slag, which had the effect of localiz-

[1] Lackawanna Boiler & Grate Co., Scranton, Pa.

[1] 61 Broadway, New York City.

ing the heat and insuring the complete fusion of all metal within its vicinity. There was no tendency for the slag to become entangled with the weld, as it was much lighter than metal and had no affinity for it.

Most conclusions about the elongation of welded specimens were erroneous, as the elongation did not occur within the weld.

Corrosion was electrolytic in character and depended upon the difference in potential of contiguous areas. Commercial iron or steel contained areas which in the presence of an electrolyte, such as moisture, were capable of forming voltaic circuits, the necessary conditions being afforded by the presence of small particles of impurities or by local conditions of strain in the metal itself.

In a welded joint, if the metal at the weld were less pure than the surrounding metal, the weld would be first attacked, and if the added metal were not homogeneous, local differences of potential in the weld itself would cause corrosion at the weld. The metal deposited by the slagged electrode was of remarkable purity and hence not so readily subject to corrosion.

John C. McCabe asked Mr. Wildt about the welding temperature of 1500 deg. fahr. which he mentioned, and how the stresses set up in the weld were eliminated. He had found the welding material varied, the per cent of elongation running from a fraction of one per cent up to the highest point, 11 per cent, and in view of the bendings or flexures that occurred in the best-formed cylinders, he failed to see how an autogenous-welded vessel, as the problem was understood, could be considered a safe one.

Was not the great difficulty with all autogeneous welding for boiler plates in general the fact that so much of the plate adjacent to the weld was heated, the elastic limit of the plate reduced and its elongation increased? asked Christopher H. Bierbaum. It was known that autogenous welds could be made that were as strong or stronger than the original metal, especially if the weld were left a little thicker than the metal itself. Under such circumstances there was no question as to the strength of the weld that could be made, but did not the internal strains and the heating of the plate induce conditions which should be very carefully determined before any theoretical conclusions could be drawn?

In his oral closure, Mr. Wildt said that the temperature of 1500 deg. fahr. was more or less estimated. He also called attention to the fact the same disturbance was set up when the process of welding approved by the Boiler Code was used as when the pencil electrode method was used. When one considered the strains due to contraction and expansion, they were very much less in the pencil method than in the approved form of welding. This was because the heat was localized and confined to a small area. In the pencil method, the weld was heated, while with the approved forged-weld process there was quite a considerable area heated along the entire length of the seam.

RAILROAD SESSION, FRIDAY MORNING

BEFORE a representative audience, the Railroad Session of the Annual Meeting was called to order by E. B. Katte, Chairman of the Sub-Committee on Railroads, who introduced Mr. T. L. Burton. Mr. Burton presented a paper on Clasp Brakes for Heavy-Passenger-Equipment Cars. The author first discussed the braking required for present-day heavy-steel-passenger-car equipment, and then gave results of several series of brake tests made by different railroads since 1902. As the author stated in his presentation, he did not attempt to describe any particular brake, but confined his remarks to what might be expected of a clasp brake properly designed and constructed.

The discussion was opened by H. H. Vaughan, who commended the author for calling attention again to the desirability of this type of brake, which has been so clearly established by experiment and experience. He said the only reason the brake was not adopted on the Canadian Pacific Railway was that they had a type of truck to which it was difficult to apply it, and that with the low speeds there was apparently no advantage in the clasp brake over the ordinary brake with a large area of brake shoe.

S. G. Thompson also agreed with the author as to the superiority of this class of brake. He said it is perfectly reasonable to think that better results will come from applying the braking force on the two sides of the wheel.

His road had the advantage of having Mr. Burton design some of their equipment in the early days of the clasp brake, and it was under his supervision that a great deal of the preliminary detail work was done.

C. D. Young also heartily indorsed everything in Mr. Burton's paper. He said the Pennsylvania Railroad had and still has quite a large number of steel cars with four-wheel trucks with the single-shoe brake, and they had come to the conclusion that the saving of brake-shoe material would justify the reconstruction, so that as far as this road is concerned there will be nothing but clasp brakes on their steel equipment in time. The same thing applied to the six-wheel-truck cars, for which it is still more difficult to get a successful design.

He emphasized Mr. Burton's contention that for the successful and economical operation of the clasp brake the design must be correct. If you do not have a correct design you will not get the results, and he knew of installations today which were incorrect and which should be modified to get the advantages to be expected from two shoes per wheel.

He thought that some day we will see the clasp brake adapted more generally to tenders, engine trucks, where the wheels are heavily loaded, and freight cars.

A written discussion was contributed by O. C. Cromwell, who outlined the experiences of the Baltimore & Ohio Railroad with clasp brakes. This road now considers this brake the standard brake equipment for heavy-passenger-equipment cars. Mr. Cromwell's discussion will be published in full later.

In closing the discussion the author pointed out that one of the most important advantages of the clasp brake is with low-speed trains, where it reduces, if not eliminates, slack action. If there is anything second in importance to stopping trains in a desired distance it is in stopping them smoothly from low speed.

What Mr. Young said on the importance of properly fitting a brake design is another explanation for the absence of illustrations in the paper of the design. He had occasion to supervise if not to make a great many clasp-brake designs, and it is the rarest thing in the world to find one design suitable for two similar but different designs of cars. With respect to the application of the brake for heavy-equipment freight cars, he said he had just completed designs for some coal cars to carry 240,000 lb. of coal, weighing about 350,000 lb. when loaded.

MR. MUHLFELD DISCUSSES COMPREHENSIVELY THE SUBJECT OF THE USE OF PULVERIZED FUEL IN LOCOMOTIVES

In the second paper of the session, John E. Muhlfeld gave the principal facts and conclusions resulting from a number of years of investigation and research and of development work in connection with the important subject of the use of pulverized fuel in steam-railway operation. Mr. Muhlfeld's paper was a comprehensive treatise covering the entire field of the subject—preparation of the fuel, storage, handling, burning, and locomotive performance. It concluded with a summary of the advantages of the use of pulverized fuel in regular road passenger and freight service and was supplemented with a number of illustrations setting forth the principal reductions to practice and results obtaining at this time.

The oral discussion of the paper was opened by W. L. Robinson, who expressed his opinion that the paper covered practically everything, although a number of points could be elaborated upon.

Mr. Robinson said that the application of powdered fuel would be a practical advantage on his own road at the present time on account of the irregularity of supply of coal and the car shortage. Using pulverized coal would do away with this entirely.

He thought the biggest thing that would appeal to the conducting-transportation side was the delays at terminals. On one of the larger roads, which uses about 6,000,000 tons of coal a year, the average mechanical delays at some of the heaviest maintaining stations are between 10 and 11 hours, and the lowest delay at dispatching stations is from 3½ to 5 hours, or an average of 6 hr. 7 min. There is no question but what if you could eliminate the ashpit delays you could cut the delays nearly in half.

One statement of the author that impressed him was that with pulverized coal more skilled manual control of combustion and assistance to the engineer in the operation of the locomotive and observation of track and signals were secured. He thought that would help a great deal toward safety.

The chairman expressed a difference of opinion with one paragraph in the paper, that the extraordinary expenditure required for first cost and fixed charge, as well for combined maintenance and operation, together with the necessity for reliability and flexibility, preclude the general use of electricity as a motive power. He thought it would not be difficult to show that the electric locomotive, and the complete electrical installation behind it, can be maintained cheaper than the equivalent steam unit. As to reliability, he believed the electric installation has been shown to be more reliable under all conditions than the steam; and as to flexibility, in some cases two electric will replace three steam locomotives, and the electric locomotive does not have to be turned round, nor go to the ashpit, nor receive coal. He admitted that at the present time the first cost precluded the use of electricity except under special conditions.

George L. Fowler took up a point not touched on in the paper or discussion,—the action of fireboxes in service. The application of powdered fuel appealed to him very strongly from the fact that apparently with it a more constant firebox temperature could be obtained. It is very difficult to appreciate how sensitive a firebox is to slight variations in temperature.

C. D. Young gave his experiences, extending over four years, in attempting to burn powdered fuel in a stationary locomotive firebox. In his own words:

"The result of that work up to this time indicates very definite limitations in the use of pulverized fuel. The first limitation we have found is that, when we attempted to burn the quantity of fuel per hour that would justify the expense of putting the device in the locomotive, we melted up most everything that we had in the firebox. Our combustion chamber gave us trouble and annoyance that would make it impracticable for us to apply the device to road operation. This can be controlled, at least we have controlled it, but as soon as we attempt to control it we offset the efficiency of combustion; in other words, we reduce the temperature of the firebox by excess oxygen, so as to protect the fire-brick in the box, then we have excess fuel for that burning rate.

He thought it very desirable, however, that everyone who has the problem that powdered fuel presents should work upon it.

Mr. Young then took up various points in the paper and discussed them in the light of his own experience, summarizing in conclusion with the statement that the powdered-fuel stoker, operating as it does with reduced stand-by losses, gives that margin of economy to pay for the stoker.

L. S. Randolph thought that in designing the apparatus for storing and handling powdered fuel, the matter of dust explosions should be watched very closely. While the author seemed to have passed over this question with very slight reference, it should be elaborated on and handled very carefully.

To G. M. Basford, who next discussed the paper, two statements stood out above all the other good ones in this paper. The first was: "The future steam locomotive, on account of its track and bridge weight and tunnel and overhead clearance limitations, will be required to produce the maximum hauling capacity per unit of total weight." We have not yet gotten fairly started on that principle, and to have that question raised in connection with the subject of improved combustion, or pulverized fuel, really was, it seemed to him, a very important thing to come before the engineers and the railroad people at this time.

The other statement of equal importance was the comparison of the work of an Atlantic type locomotive, burning pulverized fuel, with that of a Pacific type locomotive. There are so many Atlantic type locomotives in this country to-day, and the Atlantic type of locomotive really represents in this case a large number of small engines in every part of the country. This statement becomes so important because the Atlantic type, with improved combustion, can be made to do in one case the work of a Pacific type engine, and the next thought naturally is: How many Atlantic types may be made to do the work of Pacific types today? By applying this pulverized-fuel principle to new designs, it will have the effect of prolonging the life and putting back into service a good many outclassed engines on the one hand, and introduce the possibility of using it from the ground up in new design where you start with a clean sheet of paper. That has never yet been done, with the exception of the consolidated locomotive on the Delaware & Hudson.

Charles Whiting Baker was impressed with that part of the paper wherein it was stated that the pulverized-coal equipment would permit the use of low-grade fuels. In some of the special locations where such fuels are obtainable for successful development of powdered fuel, a large reduction in operating expenses may ultimately be brought about, even when the cost of fuel is taken into account.

He thought that the possibility of using this development for switching locomotives in yard service was of immediate interest. If with powdered coal you get a locomotive free

from smoke, you have taken a big step toward putting an end to the agitation against the switching locomotive with its smoke.

It would be very desirable if the author, in his closure, would state if it were possible to regulate the burners so that the amount of fuel burned could be made to correspond with the demand for steam—whether it were possible, for example, to operate a switching locomotive and not have it blow off and waste heat while standing.

Angus Sinclair considered that the progress made lately with the combustion of pulverized fuel has been greater than any made in railway operation for many years.

A lengthy written discussion of Mr. Muhlfeld's paper was contributed by E. H. Stroud, who predicted that still better results will be had than those cited in the paper.

C. W. Corning enlarged, in a written discussion, upon some of the good qualifications of powdered-fuel burning stated in the paper.

J. H. Manning wrote that the paper ably covered the ground, and confirmed the author's statements with experiences with Engine No. 1200 on the Delaware and Hudson.

S. S. Riegel lent further assurances of eventual successful operation of powdered-fuel equipment for locomotive service by referring to important successful users of powdered fuel in industrial works. He stated that the final and best results had not yet been obtained.

In his closure, Mr. Muhlfeld discussed the question of the steam vs. the electric locomotive, stating as his opinion that the self-contained motive-power unit will be the one upon which we will have to depend for handling heavy freight trains over long distances. Of course, in a terminal proposition we have other conditions, and electrification is bound to be installed.

He replied to Mr. Baker's question of the applicability of powdered fuel to switching service, that one thing which has caused a great deal of trouble is the absolute control of the fuel bed. This has only been attained recently, with the development of a special feed-governing device which gives almost any range and is very effective.

THE MECHANICAL DESIGN OF ELECTRIC LOCOMOTIVES DISCUSSED BY MR. BATCHELDER

The paper by A. F. Batchelder on the Mechanical Design of Electric Locomotives dealt with features of safety of operation, general requirements of design, adaptability to service conditions in regard to nature of traffic and track, convenience of arrangement of operating devices and location of operator as affecting safety and efficiency, power efficiency as affected by mechanical design, service-time factor, cost of maintenance of permanent way and of locomotives, and first cost of a locomotive. The paper was presented by the author, who felt that too much importance could not be given to developing to the utmost the mechanical part of the electric locomotive that is the simplest in design and highest in efficiency.

C. H. Quereau presented a written discussion, which will be published in more extended form later, in which he gave statistics which would permit a personal conclusion as to the reliability in service of the electric locomotives used on the New York Central Railroad. He thought that these statistics would probably be more satisfactory than any general statement or expression of opinion, no matter how authoritative.

Experience had shown him that the cost of maintenance of engines in switching service was about twice that of those used exclusively in road service. During the period 1912-1915 the cost of maintaining the road locomotives had been about 2.5 cents per mile and that of the switch engines about 4.8 cents per mile. For the first ten months of 1916 these figures had been approximately 2 cents and 4 cents, respectively, but he doubted whether they could be kept permanently at this level. It was only fair to state in this connection, however, that the locomotives had not been designed for switching service, and with that in view they had given remarkable results.

George Gibbs, who also contributed a comprehensive written discussion which it is impossible to abstract satisfactorily, and which will therefore be published in full later, gave some opinions of his own regarding electric-locomotive design. He stated at the outset that a complete presentation of this subject has yet to be made. All we can really do at present is to chronicle experience with various types and classes of electric locomotives in various services. Unfortunately, the total number actually in service is quite limited, and the period over which our experience runs is also, in many cases, short.

He would say, generally, however, that the elimination of reciprocating parts from the locomotive—a result accomplished in electric but impossible in steam locomotives—did not warrant us in abandoning some of the very important principles well demonstrated in steam practice; namely, that for safe and successful operation under average track conditions, high center of gravity, low dead weight below spring supports and unsymmetrical wheel and weight distribution give best results. All this applied especially to high-speed operation; for low speed similar arrangements were also desirable but not so essential.

C. E. Eveleth also contributed a written discussion, in which he endorsed the paper as bringing out all the essential elements which should be taken into consideration and properly balanced before judgment is passed in favor or criticism of the mechanical features of a particular locomotive.

With the author's suggestion of the use of a truck center pin located in a well-elevated position, all of the advantages of high center of gravity, so far as effect on rail displacement was concerned, could be obtained. On the other hand, with ordinary leading-truck designs, it appeared that the high-center-of-gravity designs would give a low-center-of-gravity effect by the action of the rear truck on the track unless the high-center-pin arrangement suggested by the author was adopted on the trucks. Apparently, if high center pins were used on the trucks, the location of the center of gravity was of little importance. He referred, of course, to symmetrically designed locomotives intended to run in both directions.

He stated the incontrovertible facts upon which, from a mechanical standpoint, Mr. Batchelder's claim for superiority of the bipolar gearless design for high-speed service is found. Features which do not seem to have had general recognition place this design distinctly in a class by itself, and it is therefore to be expected that where the system of electrification will lend itself to the use of this type of engine, its application will become very general.

The chairman, opening the oral discussion, thought that it is perfectly obvious that the only difficulty in getting the electric locomotive to ride as well as the steam locomotive is the added requirement of operating in both directions, and of course this arises from the fact that the machine must necessarily be symmetrically designed about a center, or by means of cross-equalizing an effect of dissimilar ends must be created. He thought the addition of hub springs had done more towards the easy riding of a symmetrical locomotive than perhaps any other thing. The effect is, that immediately there

is an irregularity in the track, one wheel tends to rise, to leave the track, and because of the turning effect, the tendency is to skew that axle. Because of the very sensitive springs on the top of the wheel, the wheel is almost immediately forced back to the track, and the tendency to oscillate has been broken up.

This was very noticeable on one of the late types of New York Central engines. Before the springs were added, it was possible, when running 60 or 65 miles an hour, to see the equalizers work, but after the application of hub springs, the equalizers acted so quickly that the eye could not follow them. He had always believed that it was the application of these hub springs that created the particularly easy riding of the late type of New York Central locomotives.

L. S. Randolph took up the question of the guiding action of trucks, which he thought would repay study, especially in connection with the electric locomotive.

The safety of operation was next discussed, and George L. Fowler questioned the author's statements. This discussor gave results of his investigations in regard to the lateral thrust of engines and cars upon the track. He gave diagrams on the blackboard to show why he disagreed with the author's statement that the rear driver puts an excess pressure on the rail on the outside above the other wheels. He also demonstrated by diagrams what thrust is put on the track on a curve by the wheels of various types of engines.

As to the effect of height of the center of gravity, Mr. Fowler gave his reasons for thinking that the thrust is quite as dependent upon the character of the wheel and that of the vehicle as it is upon the center of gravity. In making some investigations in which he had occasion to measure the thrust on trains running from 50 to 60 m.p.h. over an 8-deg. curve, track elevated for a speed of 24 m.p.h., he found that the locomotive did not begin to put the thrust on the rail that a sleeping car at the back end of the train did, and yet the height of the center of gravity of the locomotive and that of the sleeping car only varied about three or four inches.

Mr. Batchelder, in his closure, pointed out that one question he wanted to bring out was the desirability of having more weight on the rail at the place of the thrust. That place, by actual test, is at the rear truck. That is not from guesswork, or from theory, or from calculation, but is actual fact, tested and observed for 50,000 miles of running, for the particular purpose of finding out where the double-end locomotive took its thrust. He had witnessed rails displaced ¾ in. when the front end of the locomotive was on the track.

Mr. Fowler asked Mr. Batchelder if that were not on tangent track, and he replied that it was.

Mr. Batchelder continued that in striking a curve, running on a tangent track, you are oscillating. All the locomotives he had seen run did; if it is a tangent track they are working from side to side, providing you haven't got a "cock-eyed" truck. When the forward truck gets to one rail or the other, it hits the rail, and there is only one place to hit it, and that is at the rear end.

On a curve he had never seen any trouble with double ends, except where a large resistance was put against the curve, the trucks, in other words, putting on too much resistance. A double-end engine, according to his experience, is absolutely smooth and good running on a properly elevated curve.

In regard to Mr. Quereau's remarks as to the pivot point of the leading truck, he had to say that he knew no way of observing it, but in his opinion the outer rail would be the point of pivoting. The same discussor had spoken about the resistance tending to prevent the guiding trucks from oscillating, and he believed that this was true. With the engines the discussor had in mind there was a frictional resistance, and when once the truck had taken a position, something had to be struck before it came back into another position, and it might therefore run cock-eyed on the track and cause flange wear, and in that particular case flange wear was much preferable to oscillation.

Mr. Katte had spoken of coil springs on the box, and he would add that his experience with them had been gratifying.

Mr. Young had understood him to say that a locomotive would not run backward safely. He would rather modify that statement and say that it was not desirable to run it backwards. For that matter, he did not know of any operation of locomotives at 80 m.p.h. backwards, especially of the American type. However, in making tests of two American-type locomotives back to back, with leading trucks, it had been his experience that those locomotives, when run at as high a speed as 80 miles, did affect the track and sometimes very seriously. The defects were not immediately apparent, but they developed sooner or later.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on December 7, 1916, in Cases Nos. 87, 113-123 inclusive. In this report, as previously, the names of inquirers have been omitted.

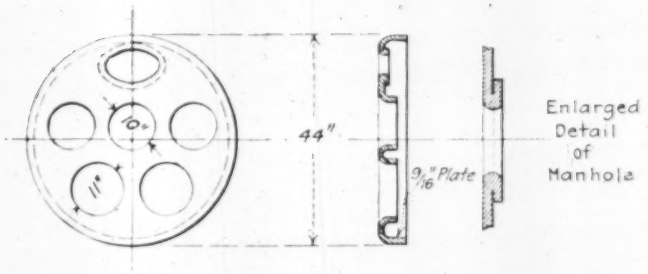


FIG. 6 SPECIAL CONSTRUCTION OF MANHOLE OPENING

CASE NO. 87

Inquiry: Is there any restriction in the Boiler Code against the purchase of steel plate by weight per square foot instead of by gage, provided there is a factor of safety of five throughout?

Reply: The Boiler Code does not specify how the plate shall be bought, but material must comply with the Code specifications.

CASE NO. 113

Inquiry: a Are the furnace sheets in all water-leg boilers, such as vertical fire-tube boilers, to receive staying as flat plates; that is, when it is necessary to use staybolts on a circular furnace sheet, is no value to be given according to the Code, to the furnace sheet due to its curvature?

b When the circumferential and longitudinal pitches are not equal, can their product be used in place of p^2, in Par. 199? Also, can it be used and made equal to the square of the values given in Table 3?

c Is it the purpose of Par. 207 to provide a greater spacing than shown in Table 3 for flat plates?

d Is Par. 257 intended to do away with the bevel shear for finishing the calking edges of plates, and does it mean that the plate edges may only be planed, milled, or chipped?

Reply: a An internal cylindrical furnace which requires staying, shall be stayed as a flat surface, and no value will be given the furnace sheet due to its curvature, in accord with Par. 212. (See also the Reply in Case No. 57.)

b No, p must be measured as specified in Par. 199.

c Par. 207 was not intended to cover the spacing of staybolts on flat plates, but was intended for staybolted surfaces where some form of reinforcement is applied.

d According to Par. 257 of the Code, in order to eliminate the incipient cracks left by shearing, the edges of the plates must be finished by planing, milling, or chipping, whether they are sheared straight or beveled.

CASE NO. 114

Inquiry: Is it allowable under Par. 333 of the Code to stamp a locomotive type boiler over the fire door, when the latter is located in the side of the furnace section of the boiler?

Reply: Such a boiler may be considered a special type, and according to Par. 333j, the stamp shall be placed in a conspicuous location. It is therefore correct to place the stamp near the fire door.

CASE NO. 115

Inquiry: Is it permissible under the Boiler Code to use manhole openings in the heads of boilers constructed as shown in Fig. 6?

Reply: Yes, when the head is flat and stayed with tubes as shown in the sketch, or otherwise stayed.

CASE NO. 116

(In the hands of the Committee)

CASE NO. 117

(Annulled)

CASE NO. 118

Inquiry: Is it permissible under Par. 185 of the Boiler Code, to build a horizontal return tubular boiler of 19/32-in. plate (1/32 in. heavier than the limit placed by Par. 185) without planing down the circumferential joints?

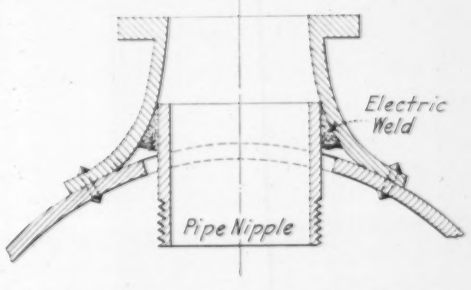


FIG. 7 WELDED CONNECTION FOR INTERNAL PIPE TO NOZZLE

Reply: The shell plates in horizontal return tubular boilers, where the plate thickness exceeds 9/16 in., must be planed down at that portion of the circumferential joint exposed to the fire or products of combustion, as required under Par. 185 of the Boiler Code.

CASE NO. 119

Inquiry: a Is it permissible under Par. 274 of the Boiler Code, for a pop safety valve with a higher lift than the maximum given in Table 8 of the Code, to use the manufacturers' rated capacity of discharge?

b Under Par. 421 of the Code, is it permissible to rate discharge capacities of safety valves proportional to the lifts, when the lifts exceed the maximum given in Table 8 of the Code?

c If for a boiler equipped with a superheater, one 3-in. or smaller safety valve provides sufficient relieving capacity, is it necessary to place a safety valve on the superheater outlet in addition to that on the boiler, or will one safety valve on the superheater outlet be sufficient for both superheater and boiler?

Reply: a According to Par. 274 of the Code, if the marked relieving capacity of the valve exceeds that given in Table 8 of the Code, the maximum relieving capacity given in Table 8 governs in determining the minimum capacity of safety valve or valves to be placed on a boiler. It will be noted that the capacities given in the Table are for bevel-seated valves; for flat-seat valves, increase these values by 40 per cent.

b In determining the minimum capacity of safety valve or valves to be placed on a boiler, the Table should be used in accordance with Par. 274.

c According to Pars. 269 and 288 of the Boiler Code, one safety valve will be sufficient for both superheater and boiler, provided one 3-in. size or smaller safety valve will meet the requirements for the minimum capacity of safety valve or valves to be provided. For greater relieving capacities than this the Code calls for two or more safety valves.

In view of the resistance to the flow of steam through certain forms of superheaters, recommendation has been made to the Committee that the Code be revised after the Public Hearing on December 8-9, to specify the use of both superheated and saturated valves, without exception, in all superheater boilers.

CASE NO. 120

Inquiry: Is it to be understood, under Par. 18 of the Boiler Code, that in order to obtain the required thickness of the shell and dome plate after flanging, that sufficiently heavier plate must be used to give the required thickness at the edges after the flanging process?

Reply: According to Par. 18 of the Code, the minimum thickness of shell plates and dome plates after flanging, must be 5/16 in. for diameters of shell from 36 in. up to and including 54 in. in diameter.

CASE NO. 121

Inquiry: Is it permissible under the rules of the Boiler Code to make a joint by welding a coupling or nipple by the autogenous process to the underside of a steel flanged feed connection?

Reply: If the coupling or nipple connection is securely fastened to the inner side of the steel flange feed connection by the welding process, the requirements of Par. 315 will be complied with.

CASE NO. 122

Inquiry: Is it permissible under the rules of the Boiler Code to weld to the inner side of a wrought steel steam nozzle a coupling or nipple connection for a dry pipe within the boiler, as shown in Fig. 7?

Reply: There is nothing in the Code to prevent the use of autogenous welding for this joint where no strain is brought on the joint through the action of the steam pressure.

CASE NO. 123

Inquiry: If a boiler is so designed that a manhole applied as required by Par. 264 cannot be used for cleaning and inspecting the boiler, would the requirements of this paragraph be met?

Reply: In requiring manholes for boilers, as specified under Par. 264 of the Code, it was the intention that the boiler should be so designed that the manhole would be serviceable for entering the boilers for cleaning and inspection, and all such boilers as referred to in that paragraph should be designed so as to accomplish this purpose.

Society Affairs

Engineering Survey

Society Affairs Section..... Page 53
Engineering Survey Section ....Page 77
Miscellaneous.....Page 97

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

OFFICERS AND COUNCIL, 1917

PRESIDENT

IRA N. HOLLIS ..... Worcester, Mass.

VICE-PRESIDENTS

Terms expire December 1917

WM. B. JACKSON ..... Chicago, Ill.
J. SELLERS BANCROFT ..... Philadelphia, Pa.
JULIAN KENNEDY ..... Pittsburgh, Pa.

Terms expire December 1918

CHARLES H. BENJAMIN ..... Lafayette, Ind.
ARTHUR M. GREENE, JR ..... Troy, N. Y.
CHARLES T. PLUNKETT ..... Adams, Mass.

PAST-PRESIDENTS

ALEX. C. HUMPHREYS ..... New York, N. Y.
W. F. M. GOSS ..... Urbana, Ill.
JAMES HARTNESS ..... Springfield, Vt.
JOHN A. BRASHEAR ..... Pittsburgh, Pa.
D. S. JACOBUS ..... New York, N. Y.

MANAGERS

Terms expire December 1917

CHARLES T. MAIN ..... Boston, Mass.
SPENCER MILLER ..... New York, N. Y.
MAX TOLTZ ..... St. Paul, Minn.

Terms expire December 1918

JOHN H. BARR ..... New York, N. Y.
JOHN A. STEVENS ..... Lowell, Mass.
H. DE B. PARSONS ..... New York, N. Y.

Terms expire December 1919

ROBERT H. FERNALD ..... Philadelphia, Pa.
WILLIAM B. GREGORY ..... New Orleans, La.
C. R. WEYMOUTH ..... San Francisco, Cal.

CHAIRMAN OF FINANCE COMMITTEE

ROBERT M. DIXON ..... New York, N. Y.

TREASURER

WILLIAM H. WILEY ..... New York, N. Y.

HONORARY SECRETARY

FREDERICK R. HUTTON ..... New York, N. Y.

SECRETARY

CALVIN W. RICE ..... New York, N. Y.

EXECUTIVE COMMITTEE OF THE COUNCIL

IRA N. HOLLIS ..... Worcester, Mass.
JOHN H. BARR ..... New York, N. Y.
ARTHUR M. GREENE, JR ..... Troy, N. Y.
D. S. JACOBUS ..... New York, N. Y.
CHARLES T. MAIN ..... Boston, Mass.
SPENCER MILLER ..... New York, N. Y.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

ELSEWHERE in this number will be found the account of the Annual Meeting. Those who were obliged to miss this convention lost an event. In order for one to progress in his work it is essential to keep in touch with the outside world and these occasions where members of the profession from every section of the country get together are an inspiration to all.

The spirit of mutual helpfulness and coöperation was especially prominent. The keynote was sounded by our Dr. Hollis in his remarks on accepting the presidency for 1917.

Dr. Hollis's speech presages a remarkable year for this Society, and it is fair to assume that other societies are similarly imbued with the sense of their obligation and opportunity.

I took breakfast on two occasions in the week of December 11 with His Excellency, Nicholas P. Melnikoff, the engineer member of the Cabinet of the Czar of Russia.

His Excellency is just completing a tour of the United States to learn American methods and to obtain information generally for the development of Russia, including such a variety of subjects as: methods of gold dredging, lumbering, brazing, smelting, lighting of cities and district steam heating.

He informed me of opportunities of the most fascinating character, for instance, there is one million water horse-power capacity of development within seventy-five miles of Petrograd. Should American enterprise see fit to at once request concessions they would be favorably granted, whereas after the war no one nation could be thus favored.

In addition to this opportunity of the Society to serve the official representative of a nation in securing information of the widest scope for its future development, I was impressed with the fact that there is an engineer in the Cabinet of the Czar. There is no such cabinet officer in the United States. We have no officer representing industry, in distinction from one representing labor and commerce.

This is the greatest industrial nation on the globe and the relation of the engineer to industry is so intimate that perhaps it is not an extravagant hope that during the progress of our country there may be a department of engineering sometime created in the Cabinet of the President of the United States.

The office of Engineer of the Imperial Cabinet, in Russia, while it did not always have this name, is an extremely old one. As early as the fifteenth century John the Terrible attached to his household engineers whom he brought over from Greece to build the Cathedral of St. Basil. Peter the Great at the beginning of the eighteenth century similarly established engineers with official titles as his personal advisers, and moreover made them his personal friends in much the same way that the President of the United States does his physician.

The Engineer of the Russian Imperial Cabinet has a great range of duties. He is the adviser of the Emperor in not only the technical matters pertaining to his palaces but to the cities known as palace cities, that is, the towns in which the imperial palaces are located, and the entire administration, including the police, is in the hands of the palace authorities.

By virtue of the fact that the imperial domains embrace vast territories, larger even than France, not only in the vicinity of Petrograd but in Turkestan and Central Asia, the Engineer is responsible for the development in forestry, lumber, irrigation, agriculture, mining, etc., and it is for these vast sections having untold wealth and resources that His Excellency invites the interest of American enterprise and capital. He told me that he would personally assist any desiring to investigate these opportunities.

With the extraordinary development of the chemical industry in this country and the happy bringing together of the American Chemical Society in intimate coöperation with the Engineering Societies by the recent invitation of the President of the United States, it has occurred to the Secretary to suggest to the members that they observe the remarkable opportunity of the mechanical engineer in chemical industry. Such work as we might undertake is peculiarly ours as distinct from other branches and obviously distinct from chemical work as such, namely, the transfer of a perfected laboratory process to a manufacturing process including plant layout, the handling of materials to secure the most efficient routing, the designing of machinery to get the best results, etc.

With the experience of the nations now at war who are working in mass production for the first time in their history, these nations will henceforth be able to supply to still better advantage all of the materials which they have been accustomed to supply.

In Canada, so I am informed, apropos of competition in manufacture, any individual in the Dominion may go into any factory making munitions and observe the processes and go out and compete. No secrecy is permitted, as this would defeat the object of defense of the Dominion.

What has been made a necessity in Canada by virtue of the war, in its fundamentals will hold as sound business policy in times of peace.

In general there is throughout the country the greatest freedom of visitation in our industries. In ten years, with quite general extension of courtesies to foreign visitors with letters of introduction through our various manufacturing establishments, only one in the whole United States has refused admittance to such a visitor when duly accredited by this Society.

What we need is the actual getting together in conference of the various heads of competing industries for the purpose of comparing costs, developing the most up to date methods for execution in the several plants on much the same basis that a consultation of management of several companies under one administration would naturally effect, so that we obtain all the benefits of wholesome rivalry in manufacture, reducing costs without loss of independence. Then the different industrial organizations should again get together in a coöperative work of selling the American product.

The part of the engineer in all of this is that he should participate in all such conferences. The more an engineer takes a national and even a world view point the more service is he to his profession.

CALVIN W. RICE, *Secretary.*

ANNUAL BUSINESS MEETING

THE annual business meeting of the Society was held in the Auditorium of the Engineering Societies Building on Wednesday, December 6th, 1916, at 10 a. m., in connection with the 37th Annual Meeting. Dr. D. S. Jacobus presided.

The Secretary presented the Annual Report of the Council for the year 1916, to which was appended the Reports of the Standing and Special Committees. This report will be published in full in Volume 38 of the Transactions of the Society, and is here given in abstract only. The Reports of Standing Committees were published in The Journal December 1916.

Abstract of Council Report

The Council has held eight monthly meetings and two special meetings, and the Executive Committee of the Council has met five times between meetings of the Council.

The Council registers with deep regret the deaths of E. D. Leavitt, and John E. Sweet, both Honorary Members and Past-Presidents of the Society. Special commemorative resolutions were passed by the Council.

Dr. Ambrose Swasey was this year elected an Honorary Member.

While this year in the affairs of the Society has been one of increased internal activities proportionate to the growth in membership and standing of the organization, and increased inter-society coöperation in matters affecting the Engineering Profession as such, the most significant development of the year has been the Society's participation in movements for the national service. In common with the other national engineering societies, our Society has been called upon by the Government to perform work for the public welfare, and, in turn, we as engineers have received recognition in legislation directly and permanently establishing our profession as an arm of the Government.

Before reviewing the conspicuous and important phases of the activities during 1916 of the membership, committees, sections and student branches, and enumerating the actions taken in joint society matters, this report first refers to the relations the Society has maintained in its service to the nation.

INDUSTRIAL CENSUS

Last year national recognition was accorded the Engineering Profession in the invitation extended to the engineering societies by the Secretary of the Navy of the United States to nominate the members of a Naval Consulting Board. This Society's representatives on the Board are Spencer Miller, Member of the Council, and W. L. R. Emmet.

To conduct the work of compiling this inventory, a Committee on Industrial Preparedness, a sub-committee of the Naval Consulting Board, was constituted with Howard E. Coffin, Mem.Am.Soc.M.E., as Chairman.

To assist this committee in its work, State Directors were appointed, one in each State for each of the national societies mentioned in President Wilson's letter, and they in turn have been generously assisted by "field aides" composed of other members of the Societies who in many cases personally visited the different plants in order to secure the required information.

The Council records its appreciation of the work of the Society's representatives in this splendid movement, which has now been carried through with complete success.

ENGINEER CORPS AND NATIONAL COUNCIL OF SAFETY

In response to an invitation from General Wood, Commander of the Department of the East, a joint committee was chosen by five national engineering societies to facilitate the carrying out of the organization of a Civilian Engineer Reserve Corps as a part of the military forces of the United States. This committee organized with an executive committee of: Wm. Barclay Parsons, *chairman;* H. S. Drinker, Wm. H. Wiley, B. J. Arnold, Ralph D. Mershon. The committee made its first report in December 1915, and in July 1916, Chief of Engineers, Lieut.-Col. E. Eveleth Winslow of the Army Engineer Corps, in writing to all the engineer officers throughout the country said, "Congress has now provided a means by which the civilian engineers can more than fully prepare themselves for that highest duty of citizens—the defense of our country." The bill became effective on July 1, 1916, thus directly and permanently establishing the Engineering Profession as an arm of the Government. Public recognition of the engineer is now as accomplished fact.

As a sequel to the work of the Naval Consulting Board, a bill has been passed by Congress providing for a National Council of Safety, consisting of five Cabinet officers and not more than seven civilians. The latter will be chosen, one each, to represent labor, industry, finance, transportation, physics, chemistry and commerce.

STANDING, ANNUAL AND SPECIAL COMMITTEES

STANDING COMMITTEES

Finance Committee. Last year, when a serious business depression in this country seemed imminent, precautionary measures were taken to conserve the interests of the members of the Society in every proper way. This conservation was carried out a little more than later proved necessary, although not more than seemed wise at the beginning of the year, with the result that we saved $24,000 to go into the surplus. This is made available to increase our working capital, a necessity by virtue of the Society's rapid growth.

All the gifts of money to the Society are intact and invested, and initiation fees have been used during the last few years to retire the certificates of indebtedness issued to pay off our share in the land of the Engineering Societies Building. Our sister societies were each able to pay off, by subscription, their individual share—$180,000—of the purchase price of this land, but with our subscriptions amounting to only about two-thirds of the gifts received by these societies, we have been able to finance the problem on another basis; yet we were the first to pay off the mortgage on the land, by means of certificates issued to the membership. Our certificates were retired on July 1, 1916.

Meetings Committee. The culmination of the work of this committee is represented in the Thirty-sixth Annual Meeting held in New York in December, 1915, and the spring meeting held in New Orleans in April, 1916. Too much praise cannot be accorded to the members of the committee for the great amount of time and work they have given to reviewing manuscripts of the papers presented and arranging the programs of these meetings.

The committee has received valuable assistance in its work from its sub-committees on Air Machinery, Cement Manufacture, Fire Protection, Gas Power, Hoisting and Conveying,

Industrial Buildings, Machine Shop Practice, Protection of Industrial Workers, Railroads and Textiles.

THE ANNUAL MEETING

The Thirty-sixth Annual Meeting was held in New York City, December 7-10, 1915, inclusive. Enthusiasm was manifested in various ways; there was a series of conferences of representatives of the Sections, at which "Extend the Local Sections" was distinctly emphasized; at the Council meetings the sentiment expressed was equally enthusiastic; the spirit of democratization was dominant, and the membership was encouraged to participate in the affairs of the Society to a greater extent.

Unusually valuable contributions to the professional program were made by several of the sub-committees of the Committee on Meetings, and by local committees. At this particular meeting, seven papers were contributed by Sections and thirteen, including reports, by sub-committees.

The papers presented were representative of the mechanical engineering work of the country as a whole, having been selected through intimate acquaintance with the subjects to be discussed and on the mature judgment of the expert engineers who constitute the different sub-committees.

THE SPRING MEETING

The Spring Meeting was held in New Orleans, April 1 to 14, 1916. The local membership of the Society, the association of local members of the American Society of Civil Engineers and the Louisiana Engineering Society, acted jointly as hosts.

Special cars were run from New York and Chicago, stopping for a day at Birmingham, where the visitors were lavishly entertained by the newly-formed section of the Society in that city.

The papers presented were all of a high order, there was a large amount of discussion, and the keynote session of the meeting, on the subject of Industrial Preparedness, aroused a great deal of interest and called forth contributions from engineers from every section of the country.

Publication Committee. The publications of the year have been The Journal, which has been issued monthly, the annual volume of Transactions, the Year Book, the sixth annual volume of Condensed Catalogues, and the Power Test Code (reprinted from vol. 36 of Transactions).

Plans are under way for the further development of The Journal to include such features as will, it is hoped, make this publication a professional necessity to every mechanical engineer.

Volume 36 of Transactions, issued during the summer, was the largest ever published by the Society and contained nearly 1600 pages.

Membership Committee. There were 1879 candidates for membership, 1143 of whom were recommended for acceptance.

Library Committee. The principal matter of interest to the Board this year has been the consideration of the plans for receiving the library of the American Society of Civil Engineers. With this library added to that of the original Founder Societies, the largest and most complete engineering library in the world will be at the service of every engineer in whatever branch of the profession.

House Committee. The House Committee has considered the alterations required in the rooms of the Society to take care of the supporting columns passing up through the rooms to carry the load of the three stories being added to the building for additional library accommodations and headquarters for the American Society of Civil Engineers. They have also advantageously placed the insurance of the property of the Society after exhaustive investigation; have most painstakingly looked after all other interests of the Society's rooms and property, and arranged the details of the President's reception at the annual meetings.

Research Committee. The work of the Research Committee has consisted in lining up definite duties and plans for sub-committee work. The committee has now several sub-committees, including Bearing Metals, Clinkering of Coal, Flow Meters, Fuel Oils, Lubrication, Cutting Action of Machine Tools, Materials of Electrical Engineering, Safety Valves, and Worm Gearing.

Public Relations Committee. The Council has under careful consideration the entire field of the Society's activities in their relation to the public, so that no active work has been taken by the Committee this year.

Constitution and By-Laws. The Committee on Constitution and By-Laws acts in an advisory relation to the Council in consideration of suggested and necessary amendments to the Constitution, By-Laws and Rules.

Standardization Committee. This committee became a standing committee of the Society by amendment to the Constitution in the spring of 1915. The action was the result of a report prepared by Mr. Henry Hess, and approved by the Council in December, 1913. The purport of the report is that the Committee shall standardize the method of making and arriving at standards rather than create standards themselves.

NOMINATING COMMITTEE

The Nominating Committee this year was appointed by the President in a way to secure the greatest possible democracy in selecting nominees for executive offices. The Sections of the Society were divided into five geographical groups and one member of the committee was chosen from each group.

The President appointed as Tellers of Elections for 1916: Robert H. Kirk, *Chairman;* Erwin S. Cooley, Harry A. Hey.

Here follows a detailed account of the work of the various special committees for the year, and of the Society's numerous activities in coöperating with other organizations, both by joint committee work and by Society representation.

Filter Report

The Report of the Committee on Recommended Practice for Standardization of Filters was presented by George W. Fuller, Chairman of the Committee. The report outlined in a comprehensive manner the present practice in the field of mechanical filtration and emphasized the need and value of a pronouncement upon the subject of the rating of mechanical filters. It concluded with recommendations on form of expressing capacity, care as to maximum demand, depth of filter bed, normal filtering material, special filtering material, rate of filtration, etc. The report will be published in full later.

Awards of Prizes

The next business was the awarding of the Junior and Student prizes for papers presented by Junior and Student members respectively. On the recommendation of the Prize

Committees, the Junior Prize for 1916 was awarded to L. B. McMillan, for his paper entitled The Heat Insulating Properties of Commercial Steam-Pipe Coverings. Honorable mention was awarded to Victor J. Azbe for his paper on Power Plant Efficiency, and Herbert B. Reynolds for his paper on the Flow of Air and Steam through Orifices.

Student Prizes for 1916 were awarded to: Boynton M. Green, Leland Stanford University, for his paper on Bearing Lubrication; Howard E. Stevens, Rensselaer Polytechnic Institute, for his paper on An Investigation of the Dynamic Pressure on Submerged Flat Plates, and M. Adam, Louisiana State University, for his paper on The Adaptability of the Internal Combustion Engine to Sugar Factories and Estates.

Honorable Mention was awarded to: M. Boyd Gordon, University of Cincinnati, for his paper on A New Type of Unaflow Engine; S. C. Williams, Stevens Institute of Technology, for his paper on Photostatic Reproduction, and Charles P. Miller, Pennsylvania State College, for his paper on Investigation of Properties of Low and Medium Carbon Steels.

IRA NELSON HOLLIS

IRA NELSON HOLLIS, President of the Society for 1917, was born in Mooresville, Indiana, March 7, 1856. In 1872 he was graduated from the Louisville, Kentucky, High School, and went as apprentice in a machine shop for building and repairing all kinds of engines, particularly those for the Ohio River steamboats. His health was not equal to the work, however, and he secured an office position with a railroad company, and later with a cotton commission house in Memphis, Tennessee.

In 1874 he entered the Naval Academy as a cadet-engineer, having taken a competitive examination along with about one hundred and twenty-five others, twenty-five of whom were appointed.

Hollis stood first on the list of those who entered, and retained this position throughout the course. When it is mentioned that in the class were included such brilliant men as the late Professor Spangler, Dr. Cooley, and Admiral Griffin, the present Engineer-in-Chief of the Navy, it will be seen that this record means a great deal. There had been a separate class for engineers, of a tentative character, for some years before, but the class which entered in 1874 was the first one to follow a four years' course and pursue studies of a general character as well as those relating particularly to engineering.

It is worth noting that when this class of young engineers went through Annapolis it was before the days of thoroughly organized technical schools and first-class textbooks, with the result that the instructors in professional subjects had little to guide them in the way of successful practice in technical education elsewhere, and had to shape the course largely in accordance with their own ideas of what was necessary, supplementing such textbooks as were available with lectures based on their own experience. Several members of the Society were among these early instructors, including Captain Charles H. Manning and the late Chief Engineers, John C. Kafer and David P. Jones, all of whom have always held an extremely high place in the affection of the young men who were fortunate enough to be students under them.

At that time the unfortunate contention between the Line and Staff of the navy was still quite strong, and its influence was felt even among the cadets. The engineers were made to feel in many ways that their status, actual and prospective, was distinctly inferior to that of their confreres of the Line. The four years' association as fellow students, and in the same classes, with the exception of strictly professional work, did much toward breaking down the ill-feeling. This had so far died out that the Personnel Board in 1897, composed of Line officers and engineers, was able to agree on a union of the Engineer Corps with the Line, and their recommendations to this effect became a law in 1899.

As a rule, it is best not to stir up old troubles, but we could not fully appreciate the stuff that was in these young engineers if we did not realize that these beginners of a new régime were in a difficult position, and that they acquitted themselves most creditably. In justice to the instructors, who were almost entirely Line officers, it ought to be said that very few of them showed any partiality; that their feeling toward the engineers was in the mass, and that individuals usually received the consideration and credit which was due them.

After graduation from Annapolis in 1878, Dr. Hollis spent three years in the Mediterranean and North Sea and on the coast of Africa in the Cruiser Quinnebaug. During his time in the navy he served also on the United States Steamships Alert, Hartford, Richmond, and the Flagship Charleston.

At the conclusion of the cruise on the Quinnebaug, and after promotion to the grade of Assistant Engineer, he was detailed as Professor of Marine Engineering at Union College, Schenectady, New York, in accordance with the provisions of an Act of Congress permitting such details in order to promote technical education. This experience at Union College was excellent preparation for what afterward proved to be his life work.

In 1884 he served with the Advisory Board that built the four ships of the White Squadron, and spent some months in the inspection of machinery at Chester, New York, and Nashua, New Hampshire. On the west coast he spent three years at the Union Iron Works, where some of the early ships for the new navy were then building, among them the Charleston, San Francisco, Monterey, and Olympia. This was a splendid opportunity for a brilliant young engineer like Hollis, as giving a thorough familiarity with the very latest types of machinery, and also for contact with some exceedingly able engineers, among whom were Mr. George W. Dickie, of our Society, who was then Chief Engineer of the Union Iron Works. Everybody was full of enthusiasm, and the daily lunch table offered a forum for the thorough discussion of the many new and interesting problems which were being solved. Dr. Hollis has often spoken of the pleasure and profit of these discussions.

His responsibility was chiefly for the machinery of the Charleston, and when that vessel was completed he went to sea in her. At the Union Iron Works he had supervised the design and construction of the machinery, and now had the opportunity of seeing how it worked in practice, and to note opportunities for improvement. While on the Charleston he was detailed at Iquiqui to the Filibuster Itata after the capture for the purpose of getting her ready for a return to the United States. He went North in her in the spring of 1891, and then went to China in the Charleston. In January, 1892, he went to Newport on the Staff of the Apprentice School on Coasters Island.

Shortly before his three years of service on the Charleston would have expired, Admiral Melville, who was the Engineer-in-Chief of the Navy, was asked to designate an officer to lecture on naval engineering at the Naval War College. As it was the first time the invitation had been extended, the Admiral felt it necessary to choose a man specially fitted for this work. After a survey of the available officers, he selected Hollis, who was ordered to the Navy Department shortly before the time for the lectures so that he might prepare them. He was peculiarly fitted for this duty by his ability as an engineer, his recent experience in the building and operation of the most modern machinery, his experience as a teacher at Union College, and his felicity as a writer and speaker. The opportunity was a fine one, because no lectures of this sort had been given at the War College previously, so that he had the whole field to draw upon. The result was exactly what his friends had anticipated, and proved the wisdom of Admiral Melville's selection. The lectures were a great success in every way, and not only aroused the admiration of the officers to whom they were delivered, but were published and served for some time as a sort of textbook on modern marine machinery.

When Hollis was ordered to the Bureau of Steam Engineering, it was not alone to prepare the lectures, but Admiral Melville had selected him to be the successor of Chief Engineer (now Admiral) Frank H. Bailey as chief designer. He was Mr. Bailey's assistant, and it is safe to say that two abler designers of marine machinery could not have been found. During this service, which lasted only about a year, Hollis suggested a number of excellent features which were incorporated in the machinery designs of that period. His last work in the navy was the preparation of specifications for the machinery of the gun-boat Nashville and the design of machinery for some of the torpedo boats.

In 1893 Harvard University was looking for a professor of engineering and wished to consider, among others, a naval engineer. The high standing of Dr. Hollis at the Naval Academy, his splendid practical record, and his famous lectures at the War College, all marked him as the man to be considered. At the suggestion of the Secretary of the Navy, on the recommendation of Rear-Admiral Sampson and Rear-Admiral Melville, he was invited to accept the Chair of Engineering, and resigned from the Navy in September, 1893, to enter on his duties at Harvard University.

At that time engineering in Harvard was at a low ebb, but as a result of the endowment for engineering by the McKay fund, it was desired completely to reorganize the engineering department and form new classes in civil, electrical, and mechanical engineering. This not only called for executive ability of the highest order, but from the fact that Mr. McKay made his money in mechanical engineering, or things connected with mechanical engineering, it was desired to select a mechanical engineer to carry out the plans for development.

At the end of two years at Harvard, Dr. Hollis was made a member of the Athletic Committee and soon after became chairman. The outdoor athletics were transferred from the old home field to what is now known as Soldiers' Field, which at that time was largely a swamp. It was recovered by dredging gravel out of the Charles River and pumping it onto the swamp. While he was chairman of the Athletic Committee, Soldiers' Field was thus made into a playground, a metropolitan driveway was put along the river, a fence was built around the field and the necessary buildings connected with athletics erected, including the Harvard stadium and boathouse.

The necessity for replacing the old wooden seats on Soldiers' Field was emphasized by a fire which burned down one of the stands during a baseball game. Fortunately the excellent management, through the students, prevented injuries, but the University then took up seriously the replacement of the wooden stands by something less inflammable. Concrete, the use of which was then novel for large structures, was adopted as the most rapid form of construction, and the stadium was built in four months, to seat about 30,000 people. The thought in connection with the size of the stadium was to limit the number of spectators to that which would include only the students and graduates and their friends, as there was no thought of making a public spectacle out of athletics. The stadium was paid for in part by money saved from the gate receipts and in part by the graduates of the Class of 1879.

Under the direction of the engineering department Pierce Hall was built for the different branches of engineering. The civil, electrical and mechanical engineering departments were transferred to the building about 14 years ago, and the instruction and courses were once more reorganized.

Up to that time Dr. Hollis was Chairman of the Committee that raised the money for the Harvard Union, and it was under his supervision that its building was constructed. In this, as well as in the designing of the stadium and in other ways, he was for years intimately associated with Charles McKim of McKim, Mead & White. In every way he entered into the University life at Harvard, apart from the engineering side, and it has been reported on good authority that President Eliot said a few years after Dr. Hollis became a member of the Harvard faculty that he was the "greatest find" in 25 years.

In the discussions relative to an understanding between Harvard University and the Massachusetts Institute of Technology, Dr. Hollis advocated effective coöperation between the two, and has always believed that it would have been wrong to erect engineering laboratories in both places.

In the summer of 1913 Dr. Hollis resigned to take the presidency of the Worcester Polytechnic Institute, where there are splendid opportunities for continuing his forceful work for the advancement of engineering education.

Dr. Hollis has always retained his keen interest in the Navy, and was a very active factor in causing the Personnel Board to be organized. He was a friend of Colonel Roosevelt, who was then Assistant Secretary of the Navy, and had discussed the project of the amalgamation of the Line and the Engineering Corps with him very effectively.

The late Francis H. Wilson, then a Congressman from Brooklyn, had also discussed this same subject with Mr. Roosevelt. The result was that Mr. Roosevelt was convinced of the importance of a careful investigation of the subject, which led him to recommend the organization of the Personnel Board; and when the project for amalgamation came up it found him already posted on the subject.

Recently, Dr. Hollis had served in connection with the work in Industrial Preparedness, and just before that with the Chamber of Commerce in Washington. He was also a member of the Commission on National Defence, and its recommendations were submitted to the various chambers of commerce in the United States looking to a better Navy, a better Army and a legalized Council on National Defence. The chambers of commerce approved almost without division, and the report of the Committee and its findings have since practically been adopted by Congress.

W. M. McF.

COUNCIL NOTES

DECEMBER 5, 1916

At the meeting of the Council on December 5, 1916, the following members were present, President D. S. Jacobus presiding: John H. Barr, R. M. Dixon, *Chairman Finance Committee,* Arthur M. Greene, Jr., James Hartness, F. R. Hutton, W. B. Jackson, Spencer Miller, H. de B. Parsons, James E. Sague, Jesse M. Smith, S. T. Wellman, E. H. Whitlock; by invitation, Dr. Ira N. Hollis, C. H. Benjamin, officers-elect, W. L. Saunders, Past-President of the American Institute of Mining Engineers; and Calvin W. Rice, *Secretary.*

Sections. W. G. Starkweather was appointed on the Boston Local Committee.

W. H. Insley, Chairman, L. M. Wainwright, Vice-Chairman, W. A. Hanley, Secretary, B. G. Mering, Treasurer, L. W. Wallace and F. C. Wagner were appointed as the executive committee of the newly-constituted Indianapolis Section.

A. L. Black and A. M. Lockett were appointed on the New Orleans Committee in place of Professors Kerr and Rugan.

C. A. Paulsmeier and E. A. Rogers were appointed on the San Francisco Local Committee.

M. E. Cooley, Chairman, E. C. Fisher, T. H. Hinchman, G. W. Bissell and J. W. Parker, Secretary, were appointed an Executive Committee of the Detroit Section.

A Section at Baltimore, Md., to include all the members of the Society within thirty miles of the City Hall, was approved.

A Section at Erie, Pa., to include all members of the Society within a radius of thirty miles of the Erie City Hall, was also approved. This Section was granted the privilege of coöperating with the Engineers Society of Northwestern Pennsylvania. J. E. Wadsworth, Chairman, C. S. Hopper, Vice-Chairman, M. E. Smith, Secretary, R. Conrader, Treasurer, and N. A. Newton were appointed an Executive Committee of the new Section.

The report of the Committee on Sections, covering the work of this committee for 1916, was received and referred to the Publication Committee for publication in The Journal; it appears elsewhere in this issue.

The Council expressed its regret that the term of office of Mr. E. H. Whitlock, both as a member of the Council and as Chairman of the Committee on Sections, would expire with this meeting, Mr. Whitlock having carried the responsibilities of the organization of sections to such a splendid success. A vote of sincere thanks was accorded Mr. Whitlock and the members of his committee.

DECEMBER 8, 1916

At the meeting of the Council on December 8, the new officers were formerly introduced. The following were present: C. H. Benjamin, Robert H. Fernald, Arthur M. Greene, Jr., Wm. B. Gregory, Ira N. Hollis, *President,* Charles T. Plunkett, new members; John H. Barr, R. M. Dixon, *Chairman Finance Committee,* James Hartness, D. S. Jacobus, W. B. Jackson, Spencer Miller, John A. Stevens, and Wm. H. Wiley, *Treasurer,* F. R. Hutton, Hon. Secretary, and Past-Presidents Jesse M. Smith and Worcester R. Warner; Henry Hess, I. E. Moultrop, Chairman of the Publication Committee, and Calvin W. Rice, *Secretary.*

Condensed Catalogues. The report of the referendum on Condensed Catalogues was received. This report indicated a vote to date of the meeting of 2373 for the continuance of this publication and of 334 against it. Thereupon the Council voted to continue the publication.

United Engineering Society. E. G. Spilsbury was elected a Trustee of the United Engineering Society.

Engineering Foundation. W. F. M. Goss was nominated to the Board of Engineering Foundation to represent this Society.

John Fritz Medal Board. John R. Freeman was elected a Trustee of the John Fritz Medal Board to represent this Society.

Executive Committee. President Ira N. Hollis, D. S. Jacobus, John H. Barr, Arthur M. Greene, Jr., C. T. Main, and Spencer Miller were appointed as the Executive Committee of the Council for 1916-17.

Major Wm. H. Wiley, F. H. Clark, and C. C. Thomas were appointed Honorary Vice-Presidents to represent the Society at the Congress of Constructive Patriotism of the National Security League to be held in Washington, Jan. 25, 26 and 27.

Regular meetings of the Council are to be held on the third Friday of each month.

The following minute was passed by the Council and directed to be entered as a part of the record of the meeting of December 8:

Voted: That the Council here assembled record upon the minutes of the Society its sincere appreciation of the untiring, unselfish and earnest service rendered the Society during the past year by its President, Dr. D. S. Jacobus.

CALVIN W. RICE,
Secretary.

PUBLIC HEARINGS BY THE BOILER CODE COMMITTEE

AS announced in The Journal several months in advance, a Public Hearing on the Boiler Code was held on Friday and Saturday, December 8 and 9, 1916, in the Engineering Societies Building, New York, for the purpose of receiving suggestions relative to changes in the A.S.M.E. Boiler Code. This Hearing was in pursuance of the following recommendation of the Boiler Code Committee to the Council:

"Your Committee recommends that you appoint a permanent Committee to make revisions as may be found desirable in these Rules, and to modify them as the state of the art advances, and that such Committee should hold meetings at least once in two years at which all interested parties may be heard."

The Hearings began at 2 p.m. on Friday under the direction of Mr. John A. Stevens, Chairman of the Committee, assisted by fourteen members of the Committee. Discussion of the Boiler Code was entertained, beginning with the opening page of the Code and continuing through paragraph by paragraph to the Appendix. Everyone interested was given full opportunity to speak on each paragraph and all discussers were invited to submit their recommendations in writing after the Hearings. It was the purpose of the Committee to secure from those in attendance as much information as possible concerning the details of every rule in the Code, with a view to determining the desirability of making changes in them.

No replies or comments were given by the Committee mem-

bers on the Code requirements during the Hearings. The Committee has arranged to meet in January to consider the recommendations offered at the Hearings in greater detail.

The attendance at the Hearings was representative of all branches of the industry, including a large number of organizations interested in the steam boiler field, from the railroads, from the boiler manufacturers, from the makers of materials used in boiler construction, and from users of boilers. Some 1500 invitations had been sent out to all those on record as interested in steam-boiler construction, and a representative delegation was present. There was an unusual delegation from the various states and municipalities interested in the enforcement of steam-boiler regulations, which was largely due to the announcement made at the American Uniform Boiler Code Congress in Washington on December 4 and 5 (see reference to the Congress elsewhere in this issue), that every state and municipality that adopts the A.S.M.E. Boiler Code shall be entitled to have a representative present at all meetings of the Boiler Code Committee. Representatives were present from five states and from the Province of Ontario, Canada.

The very limited amount of discussion offered on the Code rules was a remarkable tribute to the comprehensiveness of the Committee's original work in 1914. Very little was offered in connection with the material specifications, the principal discussion being confined to the details of boiler construction and the fittings and appliances used therewith. The detail which entailed the longest discussion was the question of the extension of Par. 186 to permit of the welding of boiler joints by other than the forging process; the advocates of the several forms of autogenous welding presented an interesting array of data in this connection. But slight changes were suggested by the heating boiler interests and also relative to the rules for existing installations. Many helpful suggestions were offered by the representatives of the various states. All of these are at present under consideration by the Committee and will be given detailed study at the meeting in January.

Symposium and Annual Reunion

On Thursday of the Annual Meeting there was held a Symposium on Aviation. Charles M. Manly, Mem.Am.Soc. M.E., consulting engineer of the Curtiss Aeroplane & Motor Co., of Buffalo, N. Y., introduced the topic with an address on the early history of aviation, covering the development from the earliest efforts recorded to present-day practice. A particularly interesting part of his talk was that which dealt with the work of Professor Langley, of the Smithsonian Institution, with which the speaker had been associated, having been the designer of the motor and operator of the machine in its trial flights.

Mr. Manly followed his paper with the presentation of a number of lantern slides illustrative of the history of aviation, and finally a motion picture of the original Langley machine as it appeared in some recent flights when it was equipped with pontoons so that it could start from the water, and had installed a new motor and propeller, and was flown over Lake Keuka.

The second speaker was Glenn L. Martin, formerly of The Martin Co. and now vice-president of the consolidation of this company with the Wright Co., known as the Wright-Martin Co. Mr. Martin has been concerned with the building of aeroplanes for the Government, especially in California, and has a record of no serious accident with any machine of his type. His talk took the form of a description of the sensations which are experienced in an aeroplane, particularly the first time one goes up, and his account of the ride which he gave Dr. Brashear over the San Jacquin was greatly appreciated by the many friends of "Uncle John" who were in attendance.

The man who is believed to be the only past-president of The American Society of Mechanical Engineers who ever piloted an aeroplane was the next speaker—James Hartness, who gave a very interesting resumé of his experience at the aviation school in Garden City last summer. At the end of his talk Mr. Hartness was surprised perhaps as much as his audience by having a view of himself in an aeroplane flashed on the screen.

The last speaker was R. B. Lea, secretary of the Sperry Gyroscope Co., Brooklyn, N. Y., who showed first by a model of a gyroscope and later by lantern views and motion pictures how the principle of the gyroscope is utilized in keeping an aeroplane on an even keel, or stabilized. Motion pictures taken from the aeroplane when it was flown around the Statue of Liberty and below and above the East River bridges showed these familiar objects of the metropolis from new and unusual viewpoints.

Following the symposium those interested in dancing were invited to go to the fifth floor of the Engineering Societies Building, and others who preferred visiting with one another were accommodated on the eleventh floor of the Society's headquarters, where Dr. and Mrs. Hollis, with Mrs. Torrey and a number of the members of the Ladies Committee acted as host and hostesses, and supper was served.

Dr. and Mrs. Jacobus were host and hostess on the fifth floor. At about 11:30 p.m. a recess was taken and supper served on this floor and also on the sixth floor, after which dancing was resumed until about two o'clock.

Smoker at Annual Meeting

Following the precedent established a year ago, a smoker was held in connection with the Annual Meeting on Wednesday evening, December 6, 1916, this time on the fifth floor instead of in the Society's rooms on the eleventh floor. As members and guests entered they were handed a blue box with the Society's name and emblem in gold on the cover, containing cigars, cigarettes and matches, which not only saved the bother and confusion of passing each smoker his needs during the evening, but also provided those attending with a souvenir of the occasion.

Frank B. Gilbreth, Mem.Am.Soc.M.E., opened the entertainment program with a short talk on his experience on a trip to Europe during the war, and in his inimitable way of making even sober things funny, he described the search of the ship in which he crossed and numerous incidents connected with its convoyance to port. His talk was illustrated with lantern views which were especially interesting when it was known under what circumstances they were taken, as from portholes or behind barriers, for under the conditions the camera could not be used in the open.

Edwin J. Prindle, chairman of the Entertainment Committee of the New York Section, presided at the smoker, and following Mr. Gilbreth's talk told some good stories himself and then introduced the performers in the vaudeville program provided, including a ventriloquist, tenor soloist, two monologists, musical comedy specialist, magician and pianist.

Refreshments were served during and after the program. About seven hundred were in attendance.

College Reunions

As in previous years, Friday night of the Annual Meeting was "College Reunion Night," and reunions were held by the Engineering Alumni of the following institutions in New York and vicinity:

Brown University Alumni gave a banquet at Brown University Club.

Cornell University Alumni gave an informal dinner at the Cornell Club.

Lehigh University Alumni held an informal dinner and smoker at the Machinery Club.

Massachusetts Institute of Technology Alumni gave an informal dinner at their Club.

Pennsylvania State College Alumni held an informal "get-together" reunion dinner and smoker at Hotel Navarre.

Polytechnic Institute of Brooklyn Alumni held its reunion at the Engineering Societies Building, at which Frank Gilbreth delivered a lecture on Motion Study.

The Purdue Club of New York gave an informal dinner at the Phi Gamma Delta Club, in honor of Dean C. H. Benjamin of Purdue University, newly elected a Vice-President of the Am.Soc.M.E.

Stevens Institute of Technology Alumni gave their annual theater party, followed by a dinner at Hotel Astor.

University of Illinois Alumni gave an informal dinner at Stewart's Restaurant.

University of Michigan Alumni gave "a regular Michigan smoker" at Keen's Chop House.

Worcester Polytechnic Institute Alumni held an informal dinner in the ballroom of the Hotel McAlpin.

Annual Meeting Excursions

Eight well-attended excursions to points of engineering interest in New York and vicinity were held in connection with the Annual Meeting. The places visited were the Telephone Building, New York City; the Equitable Building, New York City; the Otis Elevator Company, Yonkers, N. Y.; the Essex Station of the Public Service Company of New Jersey; the Stevens Milk Company, Brooklyn; the Loose-Wiles Biscuit Company, Long Island City; the New York Steam Company; New York City, and the New York Navy Yard, Brooklyn.

Plans for the excursions were in the hands of a committee of eleven, of which John N. Norris was chairman, and members of the committee acted as personal guides to introduce participants, review the features of the trip and furnish the necessary information. The accounts of the excursions are perhaps best given in the words of the guides themselves:

EQUITABLE BUILDING

On the second day of the Annual Meeting a party of members and guests of the Society visited the Equitable Building, said to be the largest office building in the world, and were fortunate in having the features of its mechanical equipment explained by the Chief Engineer. This building occupies an entire block, and extends from 55 ft. below the street to 548 ft. above it. It has 40 numbered floors and 3 basements, each of an area of about 50,000 sq. ft. To serve the 15,000 tenants and those who transact business in the building there are 6 bays of 8 latest-type traction elevators. The elevator journey from the street to the fortieth floor takes a little over one minute.

In the lowest basement the building has its own power plant, supplying heat, water, fire protection and refrigeration. The spacious engine room contains three 600-kw., two 300-kw., and one 200-kw. 240-volt direct-current engine-type generators, each driven by a horizontal, side-crank simple steam engine working at about 150 lbs., and about atmospheric exhaust.

The boiler room contains two 550-hp. and five 450-hp. water-tube boilers, arranged for use with mechanical stokers. The fuel usually burned is a mixture of soft coal and No. 3 buckwheat which is stored in three bunkers, of 800, 200 and 1000 tons capacity, respectively. On account of the great height of the building natural draft is more than sufficient for combustion purposes.

The exhaust steam from the engines is used for heating the building and for making ice. Heating is on the vacuum system, and generally an ample supply of heat can be provided without raising the pressure above atmospheric. The exhaust steam passes to an oil separator to which is attached a 30-in. riser that goes straight up to the roof. Steam for heating is taken off at the thirty-sixth floor. There is a separate system of mains for the street floor, and some of the radiators on this floor only have thermostatic control. The absorption ice machines have a capacity of 12 tons of cake ice and 100 tons total refrigeration a day. Refrigerated brine is also furnished to the restaurants in the building. As some of the brine must be pumped to the top floor, the gauge shows pressures exceeding 350 lbs.

In the pump and compressor rooms there are ejector and sump pits, vacuum pumps, compressors for the ejectors, house pumps, fire pumps, a water-filtering plant, etc. The house pumps develop pressures of 280 lbs. and more. The fire pumps have on test developed a pressure of 50 lbs. at each of four 1-in. nozzles on the roof. A duplicate system of steam mains and water connections is provided for the pumps so that no emergency is likely to disable the whole plant. There is no central exhauster for vacuum cleaning, but each floor is equipped with portable motor-driven cleaners.

SELBY HAAR.

STEVENS MILK COMPANY

The excursion to the gas-power plant of the R. F. Stevens Milk Company, Brooklyn, New York, was of especial interest. This plant is a new installation and consists of producer-gas engines for operating refrigerating machines and for generating electric current for both power and lighting purposes. The plant consists of three 300-hp. suction-type anthracite producers using pea coal; three 250-hp. four-cylinder four-cycle vertical-type gas engines, and one three-cylinder four-cycle gas engine of 150-hp. Two of the four-cycle engines are belted to refrigerating machines and are used for cold storage and ice making. The third four-cylinder engine is direct-connected to a 150 kw. direct-current generator, and the 150-hp. three-cylinder engine is direct-connected to a 100 kw. generator, furnishing current at 250 volts for general power purposes round the plant.

J. H. NORRIS.

ESSEX STATION, P. S. CO. OF N. J.

The Essex Station is situated on the Passaic River, about two miles below and east of Newark, N. J. The location gives exceptional facilities for condensing water, coal supply and storage, ash disposal, etc., and furnishes a proper electrical distribution center.

The present buildings will house approximately one-half of what is considered the ultimate capacity, although since the plant is built on the unit principle it is capable of indefinite expansion.

The boilers are placed at right angles to the generator room, and a separate building houses the electric switches, feeders, bakery, etc.

The main generating units consist of two 25,000 kva. turbines with direct-connected exciters. These turbines are supported from the basement floor line on steel framing, leaving maximum room for access to condensing apparatus.

For each turbine there are installed four 1373 hp. water-tube boilers with superheaters and underfeed stokers. The furnace gases pass through economizers and induced draft fans to self-supporting steel brick-lined stacks 250 feet high above the grates.

Much care was taken in the equipping of the station to obtain apparatus that would facilitate economical operation and also

promote the safety and convenience of the operating force.

Many thanks are due to the company for their trouble in seeing that every one who participated in the excursion had an opportunity for a thorough examination of the station.

A. T. NICKERSON.

NEW YORK STEAM COMPANY STATION "A"

The New York Steam Company has several central stations delivering high-pressure steam through pipes in the streets for both power and heating purposes in New York City. Station "B" serving the downtown district for the past 35 years has an installation of 58 boilers with a normal capacity of 16,000 hp., while the new station "A" has but 12 boilers with a capacity of 24,000 hp. This is in keeping with the progress in the matter of installation of steam mains, etc., of today as against the methods first used.

The station building is 107 ft. x 116 ft., and while in reality there are only four floors, the building is equivalent in height to ten stories. The tops of the stacks are 300 ft. from the ground. The ground floor is given up to the station auxiliaries—boiler-feed pumps, city-water service pumps, blowers, etc. All station auxiliaries will require about 1500 Boiler hp. when the station is operating at maximum capacity.

The first floor has six boilers in units of 1000 hp. normal rating each, but to be operated at 200 per cent capacity. They are automatically stoked and equipped with traveling grates for burning the smallest screenings of anthracite coal.

For steam purposes Croton water is used but is softened before entering the boilers. The service pump suctions are connected direct to the City mains with water meters between pumps and mains.

The second floor is laid out the same as the first making the total of 12 boilers. Above the second floor is the coal bunker of 3000 tons capacity. At the south end of the building are the storage bunkers—capacity 5000 tons coal storage and also the ash bunkers above referred to.

Sufficient scientific apparatus is installed to give complete detail for checking the efficiency of the individual boiler or the entire plant. The operation of the plant under maximum conditions will require thirty men, which is a saving of 75 per cent over the methods in the old station.

The steam is delivered from the plant to the street mains, whence it is distributed to the consumers both for power and heating purposes. Among the larger power consumers are several of the biggest office buildings, and it is not generally known that such large buildings as these have their own plants for the generation of electrical current for both power and light and secure their steam from the street service to drive their engines. This has been proved both practical and economical and high-speed engines have run for years without any bad effects.

CLAUDE HARTFORD.

BROOKLYN NAVY YARD

The annual excursion to the Brooklyn Navy Yard was held on December 8 and was well attended as on previous occasions. The party was received by the officers assigned by Admiral Usher and Captain Burd, and through their courtesy the members were allowed to inspect practically every part of the principal navy yard in the country.

A sight of great interest was the part of the yard where the superdreadnought *New Mexico* is now being built. This enormous ship will have a displacement of 32,000 tons and will be one of the largest in the navy.

The battleship *Arkansas* being in the dry dock for overhauling was available for inspection and some of the members went over the ship from bow to stern.

Although the large ships attracted most of the attention, nevertheless the torpedo boats, destroyers and submarines were not neglected.

The trip through the large machine shops proved that the Navy Yard is not an assemblying plant, as here were visible huge machines for turning out engines, turbines, turrets and various other apparatus necessary for complete ships. The large Diesel engines which were placed on two of the Navy colliers during the last year were built complete in this yard and one of these ships was in the harbor on the day of the excursion.

The plate shop, power plant and boat-building shop were also visited. In the last mentioned shop an exhibition was given of the method which is now used for dropping the life boats into the water quickly. Tenders and life boats were also shown in the various stages of construction.

JOHN H. LAWRENCE.

LOOSE-WILES BISCUIT COMPANY

The varied uses to which machinery can be put in an establishment, such as is maintained by the Loose-Wiles Biscuit Company, will ever be of absorbing interest to mechanical engineers. The applications of machinery at the plant held the sustained interest of the party during the entire trip.

The company generously provided guides who, starting from the roof, conducted the party down floor by floor, to the basement, showing the methods of sifting and distributing the flour to the dough mixers, the batch wagons in which the various doughs or batters are allowed to raise; then the biscuit-cutting machines and the ovens for baking, and finally the assembling and packing departments.

Of especial interest was the machinery for baking and cutting the sweet sugar-lined wafers, and the methods of making the many fancy biscuits. At the conclusion, each of the party was presented with a box of fancy crackers.

The power plant was also visited. This consists of water-tube boilers, steam turbine and a-c. generators. The engine room was a particularly interesting place.

J. H. NORRIS.

THE TELEPHONE BUILDING

An excursion to the Walker Street Telephone Building of the American Telephone & Telegraph Company was made December 6, Messrs. G. W. Peck, H. G. Spohr and A. C. Vinal of the Telephone Company accompanying the party.

On arrival at the telephone building guides were assigned and the party was taken to the third floor where the incoming cables are received and separated on to the incoming cable racks. Here is also located a large rack upon which are mounted relays and other instruments, a large fuse board with indicating lamps, and indicating fuses. Closely adjacent are located the testing boards and testing apparatus, by means of which the cables are tested at frequent intervals. In one part of the room is a switchboard and motor generator sets used for charging storage batteries, and in an adjoining room a storage battery installation is arranged. On the third floor are also located the arrangements for handling various telegraph lines and connections, most of which are leases.

The guides explained thoroughly the entire scheme of installation, opening man-holes, uncovering switchboard connections, and in other ways showing plainly and clearly just how the vast number of various pairs of wires are handled. On the fourth floor the switchboards handling long-distance calls for the metropolitan district are located. The guides demonstrated the working of all the instruments and traced out the route of calls originating in this district for cities at a distance. The operation of the recording board, directory board, distributing table, and various connected departments on this floor were thoroughly explained and demonstrated. On this and the floor above are located all of the active switchboards with their allied departments handling incoming and outgoing long distance telephone calls for New York City and surrounding territory. The operation of the board handling incoming calls from a distance, as well as the operation of the department which continually checks the efficiency of the individual operators, was shown. It was shown that in handling a long-distance call between a point in New York City and a point in Pittsburgh from seven to nine different operators were involved, as well as many thousand dollars worth of equipment.

In this building is maintained a school for instruction of candidates for positions as switchboard operators, and this school being in session an excellent opportunity was afforded the party to follow every step of the course. Particularly impressive was the great care paid to ventilation, lighting and other particulars which have a bearing upon the health and efficiency of the operator. Another impressive feature was the number of supervisors employed: about one to every five operators. In general this excursion was exceedingly pleasant and interesting.

E. S. COOLEY.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER FEBRUARY 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7500 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by February 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about March 15, 1917.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE MEMBER

California

EDMONDSON, WILLIAM G., Mechanical Engineer, Interstate Commerce Commission, San Francisco

Connecticut

PECK, CARLOS C., Foreman Rolling Mill, Bridgeport

WEST, ERNEST H., Assistant Superintendent, Bridgeport Wks., Remington Typewriter Co., Bridgeport

Florida

BAKER, C. T., Chief Engineer, Southern Utilities Co., Jacksonville

Iowa

RANSOM, WILLARD G., Salesman and Engineer, The Bettendorf Co., Bettendorf

Massachusetts

ALLEN, CHARLES L., Treasurer and General Manager, Norton Co., Worcester

DOUGLAS, ROBERT C., New York State Representative, Norton Co., Worcester

DUNBAR, HOWARD W., Assistant Chief Engineer, Norton Grinding Co., Worcester

LOVEJOY, FRANK O., Assistant Manager, The Fiberloid Co., Indian Orchard

OWEN, OSCAR L., Patent Attorney, Whitin Machine Works, Whitinsville

SMITH, EDWARD F., President and General Manager, Greenfield Machine Co., Greenfield

Michigan

DRUMMOND, R. S., General Manager and Vice-President, Detroit Steel Products Co., Detroit

Minnesota

AUSTIN, CLEM C., Salesman, American Hoist & Derrick Co., St. Paul

COMSTOCK, ELTING H., Professor of Mine Plant and Mechanics, School of Mines, University of Minnesota, Minneapolis

Missouri

COX, CHARLES G., District Manager, McIntosh & Seymour Corp., St. Louis

New Jersey

RIEWERTS, MAX, Assistant Chief Engineer, Botany Worsted Mills, Passaic

New York

BARTLETT, PAUL, Mechanical Engineer, American Technical Advice Co., Woodhaven

BARRY, RALPH E., Marine Engineer, Tebo Basin, Brooklyn

LAWRENCE, WILLIS, Chief Mechanical Engineer, Lexington Building, Interboro Rapid Transit Co., New York

ROBINSON, JOHN R., Power Plant Specialties, New York

RUE, ERNEST F., Superintendent, Engineer, Steam Ship Dept., Vacuum Oil Co., New York

Pennsylvania

GEARHART, J. A., Secretary and Treasurer, Gulick-Henderson Co., Pittsburgh

NUSBAUM, LEE, Member of Firm, Pennsylvania Engineering Co., Philadelphia

SYKES, MATTHEW A., Superintendent, Remington Arms Co., Eddystone

WOOD, JAMES H., Field Engineer, Southwark Foundry & Machine Co., Philadelphia

Tennessee

MITCHELL, WILLIAM L., Department Chief, Tennessee Department of Workshop and Factory Inspection, Nashville

Vermont

BEARDSLEY, WILLIAM H., Assistant Superintendent, Jones & Lamson Machine Co., Springfield

Canada

COOLIDGE, C. E., Formerly Chief Engineer, Howitzer Dept., The Canadian Fairbanks-Morse Co., Toronto

HARRIS, CHESTER G., Assistant to Manager, Dufferin Plant, Russell Motor Car Co., Toronto

TISSINGTON, FRANK, Chief Draftsman, McKinnon, Holmes & Co., Ltd., Sherbrooke

Philippine Islands

DUFFY, OWEN, Superintendent and Chief Engineer Insular Cold Storage and Ice Plant, Manila

Russia

SATKEVICH, ALEXANDER, Professor of Mechanical Engineering, Nicolas Academy of Engineers, Petrograd

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

District of Columbia

BURDICK, HAROLD S., Lieutenant (j. g.), United States Navy, Washington

Illinois

STARK, JULIAN E., Chief Draftsman, Crane Co., Chicago

YOUNG, WILLIAM V., Vice-President, The American Appraisal Co., Chicago

New Jersey

VOIGT, MAX T., Tool Draftsman, Bosh-Magneto Co., Plainfield

New York

BROWN, CLINTON B., Erecting Engineer, Henry Worthington, New York

DE VRIES, REIMER P., Mechanical Draftsman, Robert Sayre Kent, New York

EBEN, LEON A., Mechanical Draftsman, Jabez Burns & Sons, Inc., New York

HARTFORD, LIONEL C., Representative State of New Jersey, Manning, Maxwell & Moore, Inc., New York

KOMPASS, FRANK O., Chief Draftsman, M. T. Davison, Brooklyn

O'NEILL, JAMES H., Manager and Purchasing Agent, Machine Dept., Continental Can Co., Inc., Syracuse

RIPLEY, WILLIAM H., Marine Sales Engineer, Griscom-Russell Co., New York

ZILLGER, ARNO, Mechanical Engineer, Clark Bros. Co., Olean

Ohio

BAIRD, LYMAN S., Mechanical Engineer, Firestone Tire & Rubber Co., Akron

HELPBRINGER, JAMES N., Power Plant Engineer, Firestone Tire & Rubber Co., Akron

KERR, THOMAS H., Gas Engineer,
The Ohio Fuel Supply Co., Columbus
RETTIG, GEORGE P., Mechanical Engineer,
Cincinnati Motor Syndicate, Cincinnati

Pennsylvania

GEBHARDT, LOUIS E., Centrifugal Pump Designer,
C. H. Wheeler Mfg. Co., Philadelphia
LUKENS, WILLIAM L., Engineer in Ordnance Dept.,
Bethlehem Steel Co., So. Bethlehem
PITTS, GUY C., Assistant to Yard Engineer,
Sun Shipbuilding Co., Chester

Rhode Island

KENDRICK, ALFRED F., Mechanical Engineer,
Glenlyon Dye Works, Phillipsdale

South America

HARRIS, SIMEON W., Sub-Superintendent of Distribution,
The San Paulo Gas Co., Ltd., San Paulo, Brazil

Washington

HOBART, FREEMAN A., Superintendent,
Henry McCleary Timber Co., McCleary

Canada

SMALLWOOD, RICHARD L., Engineer and District Manager,
Canadian Buffalo Forge Co., Ltd., Toronto

India

STEPHENS, FREDERICK S., Superintending Engineer,
Seven Tea Factories, Chulsa, Zurantee and Engo Tea Cots, Jalpaiguri District

FOR CONSIDERATION AS JUNIOR

Illinois

FITZ-GERALD, GERALD, Industrial Engineer,
St. Clair County Gas & Elec. Co., St. Louis
HIMELBLAN, HARRY, Engineer,
American Steam Conveyor Corp., Chicago
MASTERS, HERBERT R.,
with B. F. Sturtevant Co., Chicago
WOOLNER, SEYMOUR A.,
with Woolner Distilling Co., Peoria

Maryland

RANDOLPH, ORLANDO R., Material Inspector,
Test Department, Baltimore & Ohio R. R., Baltimore

Massachusetts

GUETHING, THEODORE H., Assistant to Mr. John A. Stevens, Cons. Engr., Lowell
MABBOTT, HAROLD C., Charge of Mechanical Engineering Course,
Northeastern College, Boston
NOURSE, RALPH C., Assistant Foreman, Foundry Dept.,
Crompton & Knowles Loom Wks., Worcester

Michigan

TODD, CHARLES R., Superintendent,
Dail Steel Products Co., Lansing

Minnesota

DINSMORE, ARTHUR T., Superintendent,
Western Rug Co., Minneapolis
FRANCE, JOHN E., Industrial Engineer,
Crex Carpet Co., St. Paul

New Jersey

ANDERSON, HARRY T., Assistant in Tool Design Dept.,
Simplex Automobile Co., New Brunswick
BRIZZOLORA, ROBERT T.,
with Worthington Pump & Machinery Corp., Harrison
FRICK, CLIFFORD H., Assistant Boiler Room Engineer,
Public Service Elec. Co.,
HARPER, PHILIP S.,
with Worthington Pump & Machinery Corp., Harrison
LANSING, RAYMOND P., Assistant Engineer,
Bijur Motor Lighting Co., Hoboken

New York

BROWN, IRVING F., Assistant Engineer,
Westinghouse, Church, Kerr & Co., New York
GLUCK, EDWARD V.,
with Soapitor Co., New York
HUNT, HERBERT S., Assistant Mechanical Engineer,
American Sugar Refining Co., Brooklyn
KUTTUER, JULIUS, Mechanical Engineer,
Universal Leather Co., New York
SWEENEY, LOUIS M.,
Graduate Brown University, Poughkeepsie
TAYLOR, CHARLES F., Engineer,
Allied Machinery Co. of America, New York
WILSON, OLIVER W., Engineer,
Cost Engineering Dept., The Barrett Co.,

Ohio

FELDBUSH, HARRY A.,
with Worthington Pump & Machinery Corp., Cincinnati
KLEIN, CHESTER T., Vice-President,
Cookson Steam Specialty Co., Cincinnati
TREAT, MERRITT W., Inspector,
The Travelers Insurance Co., Cleveland

Pennsylvania

GINSBURG, JACOB,
with Westinghouse Electric & Mfg. Co., E. Pittsburgh
HARTMAN, JOSEPH W.,
with Cambria Steel Co., Johnstown
HEPBURN, LOUIS L., Foreman Machine Shop,
Midvale Steel Works, Nicetown
KIEHL, EUGENE, Electrical Engineer,
The Atlantic Refining Co., Philadelphia
MARX, HARRY J., Mechanical Draftsman,
Arthur Brock, Jr., Philadelphia
SCHAEDGEN, JOSEPH F., Designer,
The American Steel & Wire Co., Donora

Rhode Island

MICHELSON, HERMAN H., Designing,
Beaman & Smith Co., Providence

South Carolina

JACKSON, FREDERICK R., Assistant Engineer,
with Mr. J. E. Sirrine, Mill Engineer and Architect, Greenville

Wyoming

HAMILTON, ROBERT W. F., Assistant Superintendent,
Central Station, Wyoming Electric Co., Casper

APPLICANTS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

New Jersey

LANG, CHARLES W., Ordnance Engineer,
Sloan & Chace Mfg. Co., Ltd., Newark

Washington

WADDELL, ROBERT, General Superintendent,
Washington Iron Works, Seattle

PROMOTION FROM JUNIOR

Connecticut

HANDS, RONALD C., Supervisor of Schedules,
Winchester Repeating Arms Co., New Haven

Illinois

CRESSLER, KERR M., Engineer,
Henry L. Lea, Consulting Gas Engineer, Chicago

Massachusetts

TURNER, CHARLES H., Chief Engineer,
Osgood Bradley Car Co., Worcester

New York

BILLINGS, EDWARD J., Engineer,
Henry L. Doherty & Co., New York
DURYEE, ANDREW B., Mechanical Engineer,
Gerstendorfer Bros., New York
HILL, E. LOGAN, Assistant Engineer,
The Erie Railroad Co., New York
KNOWLTON, FREDERIC K., President,
M. D. Knowlton Co., Rochester
MESSNER, MANFRED, Engineer,
Bing & Bing Construction Co., Inc., New York
NICKERSON, CHARLES W., Superintendent of Transportation,
Westchester Lighting Co., Mount Vernon
ROGERS, ROBERT W., Chief Engineer,
Superno Co., Inc., New York

Ohio

LOTHROP, MARCUS T., Manager,
Tube & Steel Dept., Timken Roller Bearing Co., Canton

Pennsylvania

DANNER, E. C., General Superintendent,
Ganteer Works, Cambria Steel Co., Johnstown

Summary

New Applicants	91
Applicants for change of grading:	
Promotion from Associate-Member	2
Promotion from Junior	12
Total	105

NECROLOGY

HARRY D. JOHNSON, JR.

Harry Dibrow Johnson, Jr., was born in South Bend, Ind., on July 29, 1882, died in that city Noveber 14, 1916.

Mr. Johnson received his early education in the public schools of South Bend, after which he entered Cornell University, graduating in 1904. Immediately he was employed with the General Electric Company at Schenectady, N. Y., and after two years returned to South Bend for responsible work with Studebaker Brothers Manufacturing Company. During the first seven years he progressed from machinist and draftsman and assistant master mechanic, having charge of building, design and construction, power-plant operation, machine design, maintenance, repairs, methods, piece prices, factory layouts, design and construction, to the position of master mechanic and extension work director.

Mr. Johnson's varied interests included public enterprises and general charities, as well as memberships in the University Club of Chicago, the Indiana Club, the South Bend Country Club, and the Chamber of Commerce. In 1912 he became a Junior Member of the Society.

CLIFFORD E. LIPE

Clifford E. Lipe was born December 23, 1887. Securing his earlier education in the public schools of Syracuse, N. Y., he entered Cornell University and graduated from the school of engineering of that university in 1911. On a year's trip abroad he studied the automobile business from an engineering and manufacturing standpoint, and on return was engaged immediately to look after the engineering work of the Brown-Lipe Gear Company. He became chief engineer of that company, having charge of experimental engineering, including developing and testing new transmission devices, testing accessory devices brought to that company by designers and inventors, and designing or developing the company's line of four-speed transmissions. As engineer and designer with the C. E. Lipe Manufacturing Company, he designed a great variety of special devices, tools, jigs and fixtures, including a special automatic machine for drilling and reaming solid steel ball retainers. He became vice-president of the Brown-Lipe Gear Company, being a member of the Board of Directors and very instrumental in dictating the business policy of that company.

He was elected to Associate Membership in the Society in 1914.

ALFRED WATERS PROCTOR

Alfred Waters Proctor was born in Needham, Mass., May 26, 1878. Having from early youth an inclination toward things mechanical, he determined to fit himself for mechanical engineering, and in 1899 entered the Massachusetts Institute of Technology.

On leaving the Institute, Mr. Proctor acquired his first experience by working as designer and draftsman in the plants of Blanchard Machine Company and Burton Electric Smelting Company, and with Carl L. Sponholtz, architect, all in Boston. He was later employed as designer of machine tools with Western Electric Company, and in the manufacture of pyrographic tools with J. G. Tyssowski Company, Chicago, Ill.

Much of his time was devoted to inventions and the design of special machinery, for the manufacture of which he operated shops of his own in Washington, D. C.

From 1907 to 1915 he maintained an office in New York City, during which time he made a number of special investigations, including tests on inventions of pumps, tests with pumping and engine apparatus and tanks to determine the highest efficiency of differently-shaped siphon bowls, tests on speed of type bars for the Royal Typewriter Company, reports on inventions for the Crown Cork and Steel Company, chronograph tests on shoe machines for Reece Button Hole Machine Company, and ball-bearing measurements for the Hess-Bright Manufactur ıg Company.

Mr. Proctor was for seven years an examiner in the United States Patent Office, and during that time attended and graduated from Columbia University Law School, and was admitted to practice as a lawyer by the Court of Appeals of the District of Columbia and by the Supreme Court of the United States. Because of his peculiar qualifications, which now included a thorough training in the theory and practice of engineering and a wide knowledge of patents and patent laws, his services were sought as an expert in patent litigation. His success in this capacity resulted in his being retained in some of the most important patent cases before the courts in recent years, and his standing with the members of the patent bar, and the confidence and respect with which the judiciary regarded his work were such that in several cases he was invited to sit with the court as a technical adviser. It had been with some reluctance, however, that he relinquished his active work as engineer, having always a preference for actual constructive work, and he continued to act frequently as a consulting engineer.

Mr. Proctor was elected to membership in the Society in 1916, and was also a member of the University Club, the Knickerbocker Field Club, and the Young Men's Republican Club, all of Brooklyn, and of the Technology Club of New York City. His death occurred on September 10, 1916.

HUBERT LEIGH WATSON

Hubert Leigh Watson, who died in New London, Conn., October 11, 1916, was born in Philadelphia, Pa., September, 1888. He was educated in the public schools of Hackensack, N. J., and later entered Cornell University for a course in mechanical engineering, taking his degree in 1910. The following year he pursued advanced work in gas-engine design.

For practical experience, Mr. Watson began with the summer of 1909 to employ his vacation time in apprenticeships, at that time as machinist's helper in the repair shops of the Delaware, Lackawanna & Western Railroad at Kingsland, N. J.; in 1910 he worked with the American Car and Foundry Company at Berwick, Pa., in its steel car department, and in 1912 and 1913 was employed with the De La Vergne Machine Company, New York City, in erecting and testing oil engines, also doing some special tool designing.

From 1911 to 1915 he was instructor in practical mechanics in Purdue University. He was in charge of the course in gas-power-plant design and taught all sections in mechanism.

In July, 1915, he resigned from Purdue University to accept a position with the New London Ship and Engine Company, of Groton, Conn.

He published an article on Accelerating Force of Reciprocating Parts in *Machinery*, August 1916.

Mr. Watson was a member of Purdue Cosmopolitan Club, and in 1913 became a Junior Member of the Society.

AMONG THE SECTIONS

ON Tuesday, Wednesday and Thursday of Annual Meeting Week, the official delegates of sixteen of the twenty Sections of the Am.Soc.M.E., and representatives of five centers contemplating the establishment of Sections, met in conference with the Committee on Sections.

A great deal of valuable information as to the special conditions obtaining in various localities was developed and useful suggestions made which should do much to enhance the interest in this most important phase of the Society's activities.

On the first day of the Conference the delegates met at luncheon with the members of the Council and officers-elect. On that occasion the President and President-Elect took advantage of the opportunity to voice their keen interest in the activities of the Sections, and their desire for correlation of their work with that of local engineering interests whenever possible. That the Society is taking a leading part in this spirit of coöperation was evidenced by the fact that there were present by invitation at the first day's session of the Conference, representatives of the other three Founder Societies in the persons of T. J. McMinn, Assistant Secretary of the A.S.C.E., W. H. Hall, Chairman of the Sections Committee of the A.I.E.E., and A. D. Beers of the A.I.M.E.

The Sections represented and their official delegates were:

Atlanta	Earl F. Scott
Birmingham	Paul Wright
Boston	A. L. Williston and W. G. Starkweather
Buffalo	C. H. Bierbaum
Chicago	Joseph Harrington
Cincinnati	A. J. Baker
Detroit	M. E. Cooley
Indianapolis	William H. Insley
Milwaukee	Edward Hutchens
Minnesota	J. V. Martenis
New Haven	J. W. Roe
New Orleans	William B. Gregory
New York	H. R. Cobleigh and John H. Norris
Philadelphia	D. Robert Yarnall
St. Louis	Hans R. Setz
Worcester	Edgar H. Reed

There were also present representatives from the following localities:

Hartford	J. Breslav
Lowell	A. W. Vaughan
Meriden	C. H. Decherd
Providence	W. H. Paine and A. H. Annan
Rochester	Lucien Buck

SCOPE OF THE CONFERENCE

The first day of the Conference was given over to an "Experience Meeting," at which each delegate reported the work of his Section during the past year and plans for the ensuing season. A report was made by the Committee on Sections giving a resumé of what it has accomplished in the second year of its work. This report is appended.

The first section brought out the facts that generally all Sections are closely coöperating with existing engineering societies and clubs in their respective localities and thereby securing greater interest on the part of all engineers, the presentation of a higher class of papers, a better spirit of "get-together" and good fellowship and the establishment of a permanent headquarters for the engineers of the locality. Ways and means for the continuance of this forward movement were discussed, and among others the following were advanced:

1. The desirability for "pre-meeting" suppers at a reasonable price which would encourage general participation and afford opportunity for increasing acquaintanceship.
2. Provision for all attending each meeting to wear a badge, giving their names to assist in acquaintanceship.
3. The desirability of all coöperating to the utmost in this matter of good fellowship and "get-together" movement, and especially on the part of the older members in relation to the newcomers.
4. The wisdom of having short papers, well presented and not too technical in nature, with prearranged intelligent and snappy discussion and adjournment in season to enable the members to mingle for a social hour and partake of a lunch,—"Dutch" or otherwise.
5. Excursions to points of engineering interest and industrial plants, which afford opportunity for getting acquainted while learning something of value.

The subsequent sessions were taken up by a thorough discussion of proposed changes in the By-Laws of the Society with regard to rules covering the administration of the Sections, and when these are finally decided upon they will be published in The Journal.

PUBLICITY

The Conference considered that particular attention should be paid to Sections' publicity. Advance notices of meetings should not only be sent for publication in The Journal, but also to newspapers and technical papers; reporters should be invited, and abstracts of papers furnished them if desired. Publicity for the engineer has long been overlooked, and this is largely responsible for the lack of appreciation on the part of the community of the prominent part taken by engineers in public relations.

Proper methods will do much to broaden the interest of engineers and afford them equal recognition with the legal and medical fraternities, which on account of the human element in their professional work are today exerting such a strong influence in the activities of the community.

Report of the Second Year's Work of the Committee on Sections, 1916

THE first year of the activities of the Committee on Sections was devoted largely to formulating a policy which would provide for a uniform administration of the Sections with regard to their relations with the parent Society and without conflicting with conditions peculiar to their respective localities. This was accomplished through the medium of two conferences of Sections' delegates (one at each of the two general meetings held in 1915) supplemented by a large volume of correspondence.

During the past year it has been possible to inaugurate a number of innovations in the Sections' activities and it is believed that the coöperation afforded by the Society has been rewarded not alone by increased interest on the part of members located in the territory covered by the several Sections, but also through stimulating members in several districts to undertake the establishment of new Sections.

At the time of the last Section Conference in December 1915, there were Sections at the following centers: Atlanta, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Los Angeles, Milwaukee,

Minnesota, New Haven, New York, Philadelphia, St. Louis, San Francisco and Worcester. The Birmingham Section was authorized at the meeting of the Council held in December 1915. Since then five Sections have been added to the list: Baltimore, Detroit, Erie, Indianapolis, and New Orleans. Two of them, Baltimore and Erie, have been authorized in December, 1916, so that we now have twenty Sections of the Society.

There are a number of industrial centers where conditions appear to be ripe, or nearly so, for the organization of Sections, or where meetings may be held in conjunction with Sections already existing. Among these places may be mentioned Cleveland, Columbus, Hartford, Kansas City, Lowell, Meriden, Providence, Pittsburgh, Rochester and Toledo. It is suggested that existing Sections coöperate in spreading information as to the value of Sections in promoting the engineering profession and incidently the "Mutual Service" afforded by The American Society of Mechanical Engineers, because it is well that all who enter the Society do so with the understanding that they are getting an opportunity to *give* as well as *receive* service. One way in which Sections could coöperate in the development of new Sections would be to prepare an article giving concisely the value of the Section as they see it. This might be undertaken by a member of the Executive Committee who has had sufficient experience in the work to have a knowledge of what may be termed a composite opinion of the members of the Section with regard to its worth to them. A series of such articles could be used to considerable advantage by the Committee on Sections in formulating a pamphlet for distribution in localities where Sections are proposed.

During the year the President, Secretary, or Chairman of the Committee on Sections has visited practically all of the Sections of the Society excepting those located on the Pacific Coast and they were visited in the fall of 1915. In addition visits were made to Baltimore, Detroit, Erie and Indianapolis on the occasion of the Organization Meetings held at those places.

CONSTRUCTIVE ACTIVITIES

Among others, the following developments have been achieved:

A proposed set of Amendments to the By-Laws of the Society, to govern uniformly the work of the Sections. These were submitted to the Sections' Conference at the Annual Meeting, December, 1916.

Unusual recognition was accorded the Sections by President Jacobus in giving each of five groups of Sections the privilege of electing one member of the Nominating Committee charged with the duty of selecting candidates for the Council on the ballot just closed.

Another illustration of the recognition of the importance of Sections is a Resolution by the Council to present at the 1917 Spring Meeting an amendment to the Constitution to make a Standing Committee of the Committee on Sections.

A "clearing house" for motion picture films on industrial subjects and lectures has been established, and a start has been made to secure written lectures, sometimes with slides, which lectures may be presented by a member of the Section who is willing to become sufficiently familiar with the subject matter to present it.

Sections have been assisted in their desire to encourage the young engineers just out of college through an additional amount added to their appropriations for each graduate Student Member who locates within their territory. In return the Sections are expected to give these graduate Student Members all the privileges of the Section for a period of two years after graduation. Thereafter it is expected that regular application will be made for membership in the Society if one expects to continue to obtain such privileges.

The various Sections have begun in a small way to coöperate with one another through an exchange of literature and notices of meetings. This should be further developed so that whenever a member of one Section expects to visit a city where another Section is established, notification be sent in advance and if possible arrangements be made whereby the Section visited may have opportunity to entertain the visitor and have him make some remarks, or if possible deliver a technical paper.

The Journal now devotes considerable space to a portrayal of the work of Sections, and it is hoped that the Sections will coöperate not only by submitting promptly reports of their activities, but also by keeping the Editor informed regarding all engineering news of their respective districts and especially proposed engineering developments. Every Section is encouraged to nominate one of its younger members to act as a correspondent of The Journal.

Transactions of the Society should be available for the members of Sections, and as fast as Sections secure headquarters where such Transactions may be properly cared for, it is planned to provide them.

UNIFORM DATE FOR CHANGE OF OFFICERS

Another accomplishment of the year has been to secure the consent of all Sections to uniformly elect their officers between March first and the end of May so that such elections may be formally reported and ratified by the Committee on Sections and the Council at their June meetings (held the second Friday of June) and the new officers thereby enabled to uniformly begin their activities on July first.

It is hoped by this procedure it will be possible for the Executive Committees of Sections to map out their programs for the ensuing year and have dates, speakers and places of meeting decided upon, and reports thereof sent to the Society's headquarters by October first of each year.

The most recent and one of the most successful achievements in Sections' activities was a Joint Meeting by the Boston, New Haven, New York and Worcester Sections and the Providence Engineering Society at New London, Conn., on November 11, 1916. Over sixteen hundred persons attended and special trains were run from Boston and Providence and New York and New Haven. In addition to being the first Joint Meeting of Sections ever held it was at the same time the largest gathering ever held under the auspices of the Society.

ELLIOTT H. WHITLOCK, *Chairman.*
W. F. M. GOSS,
L. C. MARBURG,
WALTER RAUTENSTRAUCH,
D. ROBERT YARNALL,
Local Sections Committee.

SECTION MEETINGS

BIRMINGHAM, OCTOBER 25

An enthusiastic meeting of the Birmingham Section was held October 25 at which W. P. Caine, Assoc.Am.Soc.M.E., gave a most interesting talk on The Use of By-Product Coke-Oven Gas as a Fuel and Some of the Problems Presented in its Use at the Ensley Steel Works.

The Tennessee Coal and Iron and Rail Road Company at its Steel Plant at Ensley has between 28 and 33 million cu. ft. of by-product gas to dispose of each day. This is the surplus made at their By-Product Coke Oven Plant at Fairfield and forced through a 24-in. pipe line 8000 ft. long ,and from the Semet-Solvay Ovens located next to the Ensley Plant.

In the talk the causes of the irregularities in the delivery and demand for the gas and the lack of a gas holder were brought out in order to indicate the conditions under which it has to be used and the necessity of being able to supplement or substitute some other fuel upon short notice sufficient to care for the variations.

Descriptions were given of various types of burners used, and their application to special conditions as for heating ladles, drying ovens, mixers, open-hearth furnaces, heating furnaces, soaking pits, etc.

All burners have a chamber in which the gas and air or a part of the air necessary for combustion are mixed before the mixture is ignited in the furnace. In some the air is drawn in by the gas jet or jets, while in others it is a jet of compressed air, air from a fan blower or air blown in with a steam jet.

Experience has shown that the burners will back-fire and burn in the mixing pipe with those in which the air is drawn in and if allowed to burn in this manner, the capacity is noticeably reduced and in some instances the end of the mixing chamber has burned off. This occurs when the gas pressure is lowered or its velocity is reduced by trying to draw in too much air for the proportions of the burner. To avoid this trouble a burner was made on the multiple jet principle with a very short mixing chamber.

Following this talk, Mr. Gaboury, of the Woodward Iron Co., gave his experience on installations similar to those described by Mr. Caine. This was followed by H. P. Ryding, who called attention to the economies now effected as compared with what might

have been done had the entire installation been built new with a view to using by-product gas.

The chairman outlined the program for the coming season as follows: *December*, Flying Machines by Prof. M. T. Fullan, of Alabama Polytechnic Institute; *January*, Combustion and Combustion Chambers in Locomotive Practice, by A. T. Anthony; *February*, Dr. Ira N. Hollis, President, and Calvin W. Rice, Secretary of the Society; *March*, Illumination, by Prof. A. A. Wittig, of the University of Alabama; *April*, Prof. A. St. C. Dunstan, of Alabama Polytechnic Institute; *May*, annual meeting, Dr. Thornwell Haynes, President of Birmingham College.

PAUL WRIGHT,
Section Secretay.

BIRMINGHAM, NOVEMBER 15

The meeting held by the Birmingham Section on November 15 was its first anniversary meeting, and it was the general sense of the meeting that the Section had been successfully organized on a basis to do effective work. Two talks were given, illustrated by photographs and charts thrown on the screen by the new baloptican machine. The use of this machine is more or less original with this Section, and the results were highly satisfactory in every respect.

The first talk was given by Mr. Paul Wright, who showed a number of photgraphs illustrating the manufacture of cast-iron water-pipe. These pictures showed the operation from beginning to end of the American Cast Iron Pipe Company's plant at Acipco, Birmingham. This company manufactures 400 tons of pipe per day, and is the only pipe shop in the country that runs double shift; it also has the distinction of making pipe 16-ft. long, and is the pioneer in the manufacture of this long pipe.

Mr. J. H. Klinck led an interesting discussion of the paper by Samuel Insull presented at a meeting of the New Haven Section on April 5, 1916, The Progress of Economic Power Generation and Distribution. Each picture and chart was well illustrated by the baloptican. Mr. Klinck added several illustrations of his own experiences with different types of turbines.

In the discussion, Frank Cutler called attention to the fact that the consideration of a central power station for the Birmingham district might be the means of conserving considerable power, and at the same time take advantage of the diversity principle as strongly emphasized by Mr. Insull.

PAUL WRIGHT,
Section Secretary.

BUFFALO, NOVEMBER 1

At the meeting of the Buffalo Section held on November 1, Frank B. Gilbreth, Mem.Am.Soc.M.E., spoke on Motion Study; his lecture was illustrated with slides showing his well-known cyclograph, in which a light is fastened to the object whose motion is to be recorded, and the camera is opened to record the path of the lighted object. Mr. Gilbreth's lecture opened up many fields of thought and showed what could be done in further advancing the study of the elimination of waste, whether in motion or materials.

JOHN YOUNGER,
Section Chairman.

BUFFALO, NOVEMBER 15

Professor Wm. L. Cathcart, Mem.Am.Soc.M.E., addressed a meeting of the Buffalo Section on November 15 on The Navy; its Fleet and Naval Stations. His talk was illustrated with slides showing various phases of work in the Navy, including some splendid pictures of battleships. The speaker showed how the engineer was responsible for the modern fighting machine and pointed out that an engineer would be required more and more to express his feelings as regards the growth of a navy suitable for the adequate defense of the United States.

JOHN YOUNGER,
Section Chairman.

BUFFALO, NOVEMBER 29

Before the meeting of the Buffalo Section held on November 29, C. H. Bierbaum, Mem.Am.Soc.M.E. and Chairman of the Sub-Committee on Bearing Metals of the Research Committee, read a paper on Graphite, with special reference to its use in lubricating compounds for bearings. The paper described at the outset the experience of the Lumen Bearing Company in producing the most economic and useful bearings for particular purposes. The first field of investigation was that of the metallurgical treatment of bearing metals in the foundry; in addition it was found necessary to investigate and correct improper designs from the point of view of both the strength and proportion of the bearing, as well as the oil grooves. This in turn brought in the oil supply in general and lead to a broad investigation of the entire field of lubricants, and from the beginning of this investigation graphite promised to be a vital subject. The results obtained with this metal were so varied, however, and at times so unsatisfactory that they lead to special studies of the composition and impurities of graphite, finally resulting in the perfection of a process by means of which all objectionable impurities are removed; impurities such as mica, silicon, feldspar, iron oxide, alumina and clay to the amount of 30.7 per cent., have been removed by this process from some of the best lubricants on the market.

L. J. FOLEY,
Director of Publicity.

BUFFALO, DECEMBER 13

On December 13, Alfred P. Brush, consulting engineer, of Detroit, spoke to the Engineering Society of Buffalo on the Four-Cylinder Automobile Engine, and other engineering topics. Mr. Brush said in part:

"Considered solely from the standpoint of numbers, the four-cylinder engine is, and has been for the last ten years, the standard prime mover for self-propelled road vehicles, and in my judgment will continue to be, so long as the four-cylinder internal-combustion engine holds its place as the most satisfactory prime mover for mobile use.

It is my opinion that the six-, the eight-, and the twelve-cylinder motors have all been developed more nearly to their ultimate possibilities than has the four-cylinder engine, and it is also my opinion that the greatest obstruction to the development of the four-cylinder motor toward its ultimate possibilities has been and is its very popularity. Volume of production makes for efficiency of production and stagnation of development.

There is another very real obstruction to the development of the four-cylinder engine. It has come to be accepted as the engine for the extremely low-priced automobile.

Four of the leading manufacturers of four-cylinder-engined cars claim for their engines maximum horsepower per cubic inch of piston displacement ranging from 0.142 to 0.206, with total piston displacements ranging from 170 cu. in. to 213 cu. in., and maximum total horsepowers ranging from 25 to 35."

Mr. Brush then described a four-cylinder motor which has been produced during the past year and which developed over 0.2 hp. per cu. in. from 400 r.p.m. to 2600 r.p.m.

A general discussion of engines followed Mr. Brush's talk, and Chas. M. Manley of Curtiss Aeroplane Co., Russell Huff, Chief Engineer of the Dodge Company, David Fergusson, Chief Engineer of the Pleasure Car Department of the Pierce-Arrow Corporation, and others took part.

A local Section of the Society of Automobile Engineers was formed at this meeting. David Fergusson was elected chairman. The vice-chairman and secretary are Chas. M. Manley and David W. Sowers.

L. J. FOLEY,
Section Correspondent.

CHICAGO, NOVEMBER 17

The first meeting of the Chicago Section this season was held on November 17, and was announced as Army and Navy night. The chairman introduced William A. Moffet, Commander of the Great Lakes Naval Training Station, who told how naval cadets were prepared and showed numerous lantern slides of their quarters and features of their training. Beginning with the *Constitution*, the development of the navy was traced up to the last battleships off the ways.

It was the speaker's opinion that if we ever attain naval supremacy we must build ships larger, faster and with greater gun power than ever before; in other words, go the limit in the three features by which a battleship is rated. In this way the

present-day dreadnaught or superdreadnaught would be outclassed and soon become obsolete. Physical limits would be reached in a battleship having a displacement of 60,000 tons, 18-in. guns and a speed of 35 knots.

Lucian B. Moody, Major, Ordnance Department, Rock Island Arsenal, spoke on the army ordnance department, showing views of its factories and products and the guns now used by the army. In time of war the five arsenals would supply only a small part of the munitions needed; it would be necessary to depend largely on the output of private enterprises.

Captain Christie, of the new United States Aviation Station at Chicago, outlined the methods of training aviators, the present status of the service and the hopes for the future. A review of the difficulties of the United States aviation corps in Mexico and anecdotes from the personal experience of the speaker were heard with great interest.

ROBT. B. THAYER,
Section Secretary.

LOS ANGELES, NOVEMBER 2

A technical session of the Los Angeles Section met on November 2, when E. T. Soderholm, Mem.Am.Soc.M.E., delivered an address on Deep-Mine Hoisting, a subject which his experience qualified him to handle well. A dinner was served and attention was called to the meeting of the Engineers of Los Angeles every Thursday, at which there would be always something of interest to the members of this Section, and an invitation was extended them to attend these meetings.

FORD W. HARRIS,
Section Secretary.

MILWAUKEE, NOVEMBER 17

At a joint meeting of the Milwaukee Section with the Milwaukee Engineers Society and Milwaukee Section of the American Chemical Society on November 17, Prof. Otto L. Kowalke gave an address on the Characteristics of Base Metal Thermocouples. The address first described an investigation regarding the performance and constancy of base metal couples. For this purpose samples of couples had been purchased in the open market, the couples being calibrated against a carefully standardized platinum couple. First the couples were all calibrated with 4 in. of their lengths immersed in the furnace; second, calibration was made with 15 in. of their lengths immersed. Then the couples were all treated for 20 hours, respectively, at 400 deg. Cent., 600 deg. Cent. and 800 deg. Cent., and after each treatment the couples were separately calibrated.

The results of these treatments and calibrations showed that in many cases there were variations of 150 deg. Cent. between the calibration at 4 in. and 15 in. immersion. This difference was due to a lack of proper annealing before being put into service. Many of the couples gave very satisfactory performance and showed a variation in calibration of from 25 to 40 deg. from the beginning to the end of the test. This is not an excessive variation. Microphotographs of the wires were also made before and after heat treatment for two hours, respectively, at 400 deg. Cent., 600 deg. Cent., 800 deg. Cent. and 1000 deg. Cent.

In all cases where satisfactory calibration was found, it also happened that the metals composing the wires in the couple formed a solid solution. It was found that in each couple where silicon was used to an extent of about 3 per cent. a segregation of the metal took place, which resulted in an excessive change in calibration; the extent of this change being 150 deg. at 1000 deg. Cobalt was also investigated as a chemical element.

Various couples were made up with iron, *Advance*, michrome and constantan wires. These couples were treated in a manner similar to those described above. It was found that cobalt *vs.* *Advance* or constantan gave satisfactory calibrations. Cobalt does not get brittle so easily as does nickel, nor does it oxidize quite so readily. A combination of cobalt *vs.* nickel-iron alloy gives a most satisfactory performance. There was less than 5 deg. difference between the original and final calibrations.

FRED. H. DORNER,
Section Secretary.

MINNESOTA, NOVEMBER 9

The Minnesota Section held its third meeting of the season in Minneapolis, Minn., on November 9. The speaker was Dr. E. F. Friedman, chief chemist of the McLaughlin, Gormley, King Co., of Minneapolis, Minn., who addressed the meeting on Coke and Its By-Products. The talk proved exceedingly interesting and was followed by a lively discussion, during which the opinion was expressed that the inferiority of the dyes manufactured in this country is due not to lack of knowledge, but to the fact that our manufacturers will not take the time to carry the reduction of the crudes down to the proper base.

D. M. FORFAR,
Section Secretary.

NEW HAVEN, NOVEMBER 15

The Fall meeting of the New Haven Section, held on November 15, was held in two sessions as usual. At the afternoon session, papers were read on Methods of Testing Metals, by Prof. W. K. Shepard, and on Applied Metallography by Prof. C. H. Mathewson. These were followed by discussion of the subjects by Mr. Skinner, of the Westinghouse Company, Mr. Staples, Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., and others. The Hatamond Laboratory was thrown open to the meeting, and dinner was later served in the Yale Dining Club Hall to visiting engineers.

The evening session was opened by Calvin W. Rice, Secretary of the Society, who gave notice of the 37th Annual Meeting to be held in New York, December 5 to 8. Prof. Breckenridge announced that an exhibition would be given by the Yale Mechanical Engineers Club in the Mason Laboratory, December 8. A paper was read by S. J. Berard, Instructor in Machine Design of Sheffield Scientific School, on Methods of Duplicating Drawings, and Frank B. Gilbreth, Mem.Am.Soc.M.E., spoke on Developments in Time-Study Methods and Devices, both of which brought out considerable discussion on the application of photography to engineering. Mr. Berard gave an illustration of blueprinting by exposing a tracing in the stereopticon and almost immediately showing the blueprint on the screen. Programs were prepared by the blueprint department of the Mason Laboratory as examples of methods of duplicating from negatives.

A full account of this meeting is published elsewhere in this issue.

E. H. LOCKWOOD,
Section Secretary.

NEW ORLEANS, OCTOBER 2

A joint meeting of the Louisiana Society of the members of The American Society of Civil Engineers and the New Orleans Section of our Society was held on October 2. The chairman announced a new policy for the Section, by which full coöperation might be maintained with the Louisiana Engineering Society without any conflicts of work. Under this policy, the preparation of new papers of merit is to be confined largely to the Louisiana Society, and the activities of our Section are to be devoted to the discussion of papers which shall have appeared either in The Journal or Transactions.

The topic of discussion of this meeting was the paper of G. C. Noble, entitled The Design and Test of a Large Reclamation Pumping Plant, published in the May, 1916, issue of The Journal and later selected by the Committee on Meetings for presentation at the Annual Meeting in December, 1916.

Professor Gregory and Messrs. Shaw, Hutson, Okey, Delery, Nelson, Dusenbury, Burwell and Olson participated in the discussion of this paper, bringing out a number of points of interest not previously developed. This discussion will be referred to Mr. Noble for his reply.

H. L. HUTSON,
Section Secretary.

PHILADELPHIA, NOVEMBER 28

On November 28, a meeting of the Philadelphia Section was held in the auditorium of the Philadelphia Engineers' Club. Mr. MacCoull of the Westinghouse Machine Co., of Pittsburgh, spoke upon the subject of mechanical development of aviation. He pointed out that from ancient times, it has been man's insatiable ambition to conquer the air, and history from the earliest times is marked by accidents occurring from experiments with various types of flying machines. The most rapid progress in the development of air machines has occurred in the past ten years.

Mr. MacCoull's paper laid particular stress upon the development of aeroplane engines, and gave instances of engines developed to meet the requirements of the very least possible weight per h.p. It is almost unbelievable that successful engines have been constructed which weigh only three or four pounds per h.p. His lecture was illustrated throughout with a number of fine lantern slides showing the development of the aeroplane engine within the past ten years. Valve arrangements and cooling systems were also treated in his paper.

Following Mr. MacCoull's paper, Dr. C. E. Lucke, Mem.Am.Soc.M.E., Dean of the Department of Mechanical Engineering of Columbia University, gave a very graphic description of the problem of aeronautical engine design. Dr. Lucke is Chairman of the Advisory Aeronautical Committee, appointed by the War Department, and showed by his talk that he was intimately familiar with the difficulties involved in successful aeroplane engines. Dr. Lucke was somewhat pessimistic in his view of the situation as to the dependability of modern aeroplane engines. Take any five engines, Dr. Lucke said, and start them and leave them alone, and hardly three can be depended upon to run without attention for over two hours. He felt as if the problem was just beginning to be solved, and as soon as capital became interested in the matter and the manufacture of aero-craft took its place on a plane with other lines of industrial work, then would the development of the engine begin in earnest. It was estimated that it would require from $50,000 to $500,000 to develop a good aeroplane engine and embody all the most recent improvements.

Dr. Lucke talked about carburation, the necessity of lightest possible power plant, fixed cylinders versus rotary cylinders, ignition, engine housing, crank cases; analyzing his talk throughout with the use of curves drawn upon the blackboard. Dr. Lucke thought that not sufficient attention had been paid by designers to stresses involved, and emphasized the necessity for designing to meet the heat carrying conditions. The great problem, therefore, is to get together a sufficient amount of design data to enable engineers to handle the problem in a more scientific and thorough manner.

Although an American was the inventor of the present aeroplane, it is much to our shame that the last two or three years has seen Continental Europe considerably outdistance us in the progress made in aviation.

Discussion on the subject was led by Dr. Jos. A. Steinmetz of the Aero Club.

W. R. JONES,
Section Secretary.

PROVIDENCE, NOVEMBER 22

At the November meeting of the Providence Engineering Society, held in the Engineering Building of Brown University on the 22nd, definite steps were taken for the winter's activities by the formation of four sections, which with the section on fire protection previously organized make five sections to start with. The new sections are: Machine Shop, Efficiency and Scientific Management, Structural Engineering and Designing and Drafting. It is expected that they will immediately take up their work and organize interesting meetings in this department of the Society's activities.

The speaker of the evening was Mr. Nelson B. Lewis, Chief Engineer of the Board of Estimate and Apportionment, Bureau of Public Improvements, New York City. His address was on the subject of City Planning as an Engineering Problem, and was well illustrated by lantern slides. He pointed out the serious situations which have arisen in several of our large cities because this feature of the city's activities was not given proper consideration. For instance, a street system once established continues almost indefinitely, and therefore should be carefully planned; a street layout and a transportation system are the means by which the people pass from their homes to their work, recreation and amusement, and so should be conveniently arranged. Park and recreation facilities and the importance of the location of public buildings, both with regard to their convenience and appearance were discussed.

ALBERT E. THORNLEY,
Corresponding Secretary.

ST. LOUIS, DECEMBER 6

The St. Louis Section participated in a joint meeting of the Associated Engineering Societies of St. Louis, held on December 6, under the auspices of the Engineers' Club of St. Louis. Members and guests were agreeably and instructively entertained by photoplays of unusual merit on the subjects of railroad safety and the evolution of transportation from the time of the squaw with her papoose on her back to the present electrification of the Chicago, Milwaukee and St. Paul Railroad. These were supplemented by a paper on Railroad Trespassing, by A. A. Krause, Commissioner of Safety of the Missouri, Kansas & Texas Railway System.

L. A. DAY,
Section Secretary.

ST. LOUIS, DECEMBER 13

The Associated Engineering Societies of St. Louis and the Engineers' Club attended a lecture, dance and luncheon given at the club rooms of The United Railways Company, St. Louis, on the evening of December 13. Mr. A. G. Allan, Assistant Engineer, Valuation Department, Missouri Pacific Railway, spoke on Some Experiences of a Civil Engineer. The talk was non-technical, describing, with a personal touch, peculiar features encountered during twenty years of railroad, canal and reservoir building in the West and was illustrated by lantern slides from photographs of the different classes of construction. Mr. Allan's address was the second one enjoyed by the members of these societies in 1916.

L. A. DAY,
Section Secretary.

STUDENT BRANCHES

BUCKNELL UNIVERSITY

A meeting of the Student Branch of Bucknell University held November 6 was the occasion of admitting to active membership in the Branch the Junior Mechanical Engineers. The topic discussed at the meeting was The Function of the Sales Engineer and His Relation to Machine Design, and a paper on that subject was read by Raymond E. Sprenkle; comparing the duties of the sales engineer of the present with the same service as it was in the past, he brought out the opportunity of the sales engineer to study the requirements of the users of machines with a view to discovering what modifications of standard types will be needed to effect an increase in production or decrease in cost of installation, and so meet competition and the conditions presented by novel machinery problems.

The subject was further discussed by Professor Burpee, Mem.Am.Soc.M.E., who developed other possibilities for advancement in the work of the sales engineer.

C. M. KRINER,
Branch Secretary.

CASE SCHOOL OF APPLIED SCIENCE

The Student Branch of the Case School of Applied Science held its regular monthly meeting on December 6. Mr. M. Luckiesh, of the N.E.L.A., gave an interesting talk on the subject of Light, Shade and Color. Mr. Luckiesh as head of the research department of the association has made a marked advance in perfecting lighting facilities. A conspicuous work of his department has been the development of artificial daylight. With the aid of diagrams and illustrations he explained the fundamental theories and practical features of his science, including the importance of color as a factor in better lighting, and emphasizing the prominence of light, shade and color in the arts.

A. TREUHAFT,
Branch Secretary.

UNIVERSITY OF CINCINNATI

The meeting held by the Student Branch of the University of Cincinnati on October 20 was the initial meeting for the year 1916-17. Branch President Cowell, presiding, outlined the plans for the coming year, reminding the members to prepare for the Spring Meeting of the Society to be held this year in Cincinnati.

The meeting was addressed by A. J. Baker, Mem.Am.Soc.M.E., who is connected with the sales department of the Cincinnati Milling Machine Company, and who gave an instructive and interesting

forecast of the problems which will confront the engineer at the end of the European war.

Short talks were also given by Prof. A. L. Jenkins and C. A. Joerger, of the University faculty.

EARL A. BOTTS,
Branch Secretary.

UNIVERSITY OF COLORADO

At a meeting of the University of Colorado Student Branch, held November 23, plans were completed for a trip of the members of the Branch to the sugar factory at Longmont, Colorado, which is the third largest factory of its kind in the world and offers many points of interest to the mechanical engineer. A blackboard talk on the general outlay of the plant was given at the meeting and on the 24th the plan was consummated by the trip to the plant.

R. F. HAMILTON,
Branch Secretary.

CORNELL UNIVERSITY

The first meeting of the Student Branch of Cornell University was held November 13, at which Prof. Rolla C. Carpenter, Mem.Am.Soc.M.E., Chairman of the Branch, outlined the aims of the Society and the advantages to be gained from membership therein, bringing the student into more intimate touch with engineering practice as it is today, by the presence of prominent engineers at meetings of the Student Branches to present important engineering topics. The meeting was addressed by Professor Jacoby of the College of Civil Engineering of Cornell University, an authority on bridge design, who, in a talk on this subject, discussed the fall of the Quebec Bridge, expressing his opinion that the disaster was due not to any negligence on the part of the engineers in charge, but rather to the fact that the science of engineering was not far enough advanced to insure its success; that the construction of this bridge had been the most gigantic task of its kind ever attempted; the engineers had no precedent to follow and at best their success was only a probability. Officers of the Branch were elected for the year, as follows: Chairman, Professor Carpenter; President, W. C. Bliss; Vice-President, R. O. Compton; Secretary, S. M. Barr, and Treasurer, W. W. Robertson.

S. M. BARR,
Branch Secretary.

UNIVERSITY OF ILLINOIS

An interesting talk on Industry in Bulgaria was a feature at the meeting held November 16 by the Student Branch of the University of Illinois, in which P. Gherganoff, a native of Bulgaria, outlining the geographical formation of that country and its consequent effects on the life of the people, told of their economic products, their travel routes, railroads and the wonderful opportunities for water-power development, which are being readily seized by engineers.

At the meeting held by this Branch on December 7, F. M. Van Deventer gave an illustrated lecture on The Use of Blast Furnace Gas for Power Purposes, comparing blast-furnace gas with producer gas and showing that a large conservation of energy might be effected by the use of blast-furnace gas in boilers and internal combustion engines. The apparatus necessary to prepare the gas for use in engines was shown by lantern slides, as were also the different power units throughout the country where this gas-energy is available, while other slides gave views of the details of large modern internal combustion engines.

V. S. DAY,
Branch President.

KANSAS STATE AGRICULTURAL COLLEGE

The Student Branch of Kansas State Agricultural College held its third regular meeting this season on November 2. Several subjects of interest were discussed, Mr. C. A. Frankenhoff giving a talk on the Utah Copper Company, followed by J. I. Brady, who took up the subject of Ore Treatment by the same company. These were supplemented by A. C. Arnold in a talk on the Shell Plant of the Hart-Parr Company, and the discussions were concluded by E. T. Whitcomb with remarks upon the Manufacture of Shells at the Plant of the Hart-Parr Company.

WM. N. CATOY,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

The November meeting of the Student Branch of Pennsylvania State College was held on the 27th. R. L. Sackett, Mem.Am.Soc.M.E. and Dean of Engineering of Pennsylvania State College, spoke to the meeting on Power Plants, illustrating his talk by lantern slides showing the ground plans of several plants as well as methods in use for the convenient handling of coal with the greatest saving of time and labor.

The meeting called for a member to represent the Branch at the Annual Meeting of the Society in New York, with the result that Mr. Harry Hammond attended for that purpose.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

About 200 new members were voted into the Student Branch of Massachusetts Institute of Technology at its first business meeting on October 13. There were interesting talks by Prof. E. F. Miller, Mem.Am.Soc.M.E., and honorary chairman of this Branch, Prof. A. E. Norton, Mem.Am.Soc.M.E., Mr. H. L. Coburn, Mem.Am.Soc.M.E., and Mr. J. O. DeWolf, Mem.Am.Soc.M.E. Plans were made for a visit by the members of the Branch to the Waltham Watch Company's plant on October 26.

The first Student Night of this Branch was held November 10, the entire program being carried out by student members of the Society, including a talk by A. E. Keating on an investigation of the efficiency of a boiler plant in Bridgeport, Conn., remarks on engineering opportunities in China by H. C. Ling, and a short account of tunnel construction by W. J. Beadle, based on his work in the New York tubes.

The members of the Branch entertained about twenty guests from the Institute on an excursion to New London, November 11.

EDWARD W. ROUNDS,
Branch Secretary.

PURDUE UNIVERSITY

The meeting held on November 28 by the Student Branch of Purdue University was instructively entertained by motion pictures showing the Indianapolis plant of the Ford Motor Company, which brought out the high efficiency attained by modern labor-saving machinery as applied in the manufacture of Ford cars. Views of safety appliances, schools for the instruction of foreigners and the supervision of foodstuffs supplied to employees emphasized the welfare campaign as conducted at the Ford plant.

G. A. RUESS,
Branch Corresponding Secretary.

WASHINGTON UNIVERSITY

A resumé of an inspection trip to the Ford Motor Company's plant at Detroit, Mich., was the subject at the meeting of the Student Branch of Washington University, St. Louis, Mo., on November 23. The discussion embraced the features of axle design, motor assembly, motor block and testing, commutator and distributor, and observations made at the plant of the Detroit Edison Company on boilers, student members Page, Kurtz, Thumser, Keysor and Conzelman participating in the discussion, after which Prof. F. E. Berger, Mem.Am.Soc.M.E., gave his impressions of the practical instruction of seeing these plants in operation.

WALTER KURTZ,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

The month of November is reported by the Student Branch of Worcester Polytechnic Institute as having been of great interest.

On November 3, Gershom Smith, vice-president and general manager of the Tabulating Machine Company, of New York, addressed a meeting of the Branch on the subject of cost accounting, explaining the several ways in which shop costs are accounted for, the method of apportioning the burden and the modern system of tabulating cost accounts by machine. To illustrate these points Mr. Smith had on the platform a group of tabulating machines de-

vised and patented by Dr. Herman Hollerith, of Washington, D. C., Mem.Am.Soc.M.E., which were the machines used by Dr. Hollerith in tabulating census returns, and were shown to do very wonderful work, being in use among prominent business concerns, especially the large railroads.

On November 11, by invitation from the parent Society, the members of this Branch attended the submarine exhibition at New London, Conn.

On November 14, Dr. D. S. Jacobus, while in Worcester to attend a meeting of the Worcester Section of the Society, addressed the Student Branch, taking as his subject Some Points Relative to Steam Engineering. The opportunity of meeting Dr. Jacobus was enjoyed by the members of the Branch.

The most important feature of the meeting held by this Branch on December 4 was an instructive talk on the Heat Treatment of Steel, by Chester M. Inman, who discussed the subject from experience gained largely through his two years' connection with the United States Steel Company in Canton, O. At this plant the speaker had been to a considerable extent in charge of certain phases of their heat-treatment work. In showing what was to be expected from certain heat treatment, Mr. Inman explained how such results were gained, why certain qualities in steel were desirable, giving the students the meaning of the terms ferrite, pearlite and cementite and the reasons for their presence, as well as their composition. The results of Mr. Inman's experience in the use of the Shore scleroscope and the Brinell hardness tester were given, as well as some insight into the questions of elastic limits and yield points, with their relation to each other.

H. P. FAIRFIELD,
Branch Corresponding Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

TECHNICAL GRADUATE, age 30 to 35, practical experience in manufacture and building of steam and hydraulic machinery. Man preferred with wide shop experience, capable of directing men. Location Ohio. Interview arranged only after examination of statement of qualifications, records and compensation expected. 328

LARGE PUBLIC INSTITUTION of middle Northwest seeks services of strictly high class man who can conduct classes and lectures on automobiles. Must be technical graduate with practical experience and not afraid of work. 421.

DESIGNER. Technical graduate. Experienced in design of small intricate machinery. Location New York. 424

ENGINEER who combines faculty for writing logical interesting technical reports with ability to turn these into reliable newspaper stories. Single, age about 30. Technical education. Experience in building construction and if possible general knowledge of power-plant engineering. Demonstrated ability as writer displayed through editorial and similar work. Name confidential. 594.

INSTRUCTORS for school of mechanical trades in Iowa. Salaries $1,000 to $1,200 per year; promotion dependent to large extent upon commercial work which can be turned out during the year.

(*a*) Energetic young man with some business ability to take charge of automobile department; must know his subject thoroughly as department is doing large repair business, and must be able to build up department educationally and commercially. Competent to teach in automobile lines, including electric cranking, lighting, and ignition course, be able to organize material and work in such way that maximum number of students can be handled with minimum teaching force and expense.

(*b*) Man to handle foundry and machine shop and possibly forge. 676.

PUBLICITY ENGINEER to take charge of firm's publication and write all advertising copy. State age, experience and salary expected. Location Illinois. 687

YOUNG ENGINEERS, experienced in manufacture and analysis of metals. Salaries $65 and $80 per month to start. Location New Jersey. 689

DRAFTSMEN with experience on electric traveling cranes. Permanent employment and good wages to competent men. Location Ohio. Apply by letter. 693

EXPERIENCED DRAFTSMAN on water-tube boiler work as detailer and designer. $1,200 to $1,500. Permanent position and good prospects for right man. Location Pennsylvania. 695

ASSISTANT TO MANUFACTURING EXECUTIVE. Mechanical engineer. Must show successful experience in same line of work, and also speed, energy, endurance, initiative, aggressiveness, courage, accuracy, memory, good judgment, strong sense of propriety. Location Detroit. Name confidential. 696

ESTIMATING ENGINEER. Engineering and estimating experience required as involved in formulating selling prices and calculation of proper size of steam, gas, pumping engines, air and gas compressors and heavy special machinery. Technically trained man desired. Give experience; references and salary desired. All correspondence strictly confidential. Location Ohio. 697

SUPERINTENDENT for large manufacturing plant. Must be familiar with manufacturing methods for producing small interchangeable parts of brass, steel, and iron. State age, education, experience and salary desired. 699.

REPRESENTATIVE for large concern manufacturing one type of machine tool, to work in conjunction with agents. Previous selling experience not necessary. Good mechanical ability most desirable. Should be about 30 and have had mechanical training in conjunction with wide shop experience and should possess knowledge of best practice in machine tool uses. Location Ohio. 706.

YOUNG ENGINEER with some office and shop training for position as confidential man in office. Will have charge of various cost price and engineering records and assist in oversight of engineering salesmen, to eventually work into considerable amount of sales engineering correspondence. Location Detroit, Mich. 712.

LARGE EUROPEAN COMPANY requires machine-tool salesman speaking French, Italian or Russian, with practical experience, to assist in purchasing machine tools in United States. Suitable man would later be required to reside abroad. Apply by letter. 715.

DESIGNER. Engineering graduate, with experience in automatic machinery. Good opportunity to clever man. State education, experience, and salary expected. Location New Jersey. 717.

DRAFTSMAN. Permanent positions for high-grade men. Location Plainfield, N. J. 719.

CHIEF ENGINEER OF STEAM PLANT of 10,000-kw. capacity (turbine plant). Willing to pay for high-grade engineer. Location Pennsylvania. 721.

YOUNG ENGINEERS on power-plant operation and testing. Apply by letter. Location New Jersey. 722.

MACHINERY SALESMAN, salary and commission, with guarantee of $150 per month. Experienced in boiler and power-plant work. Location New York. 723.

MECHANICAL ENGINEER, with several years mechanical experience, for investigating mechanical operations and equipment and developing new apparatus in connection with operations of large industrial concern. High-grade man desired. In first letter state age, experience and training. Location New Jersey. 724.

COMBUSTION ENGINEER experienced in hand and stoker firing of bituminous coal, for studying boiler efficiency and other combustion problems. High-grade man desired. Location New Jersey. 725.

DRAFTSMEN. For large rubber concern in Ohio, number of competent draftsmen on machinery layouts, piping and electric wiring. Also two tracers and a checker. Location Ohio. 727.

PRODUCTION AND PLANT-EFFICIENCY WORK. Technical graduates. Preferably two or three years' experience. Must be capable, wide-awake and want to make good. Well-established company. Location Indiana. Unusual opportunity for several men of ability to work into organization. 728.

MECHANICAL DRAFTSMAN, with about six years experience in detailing machinery. Location New Jersey. 729.

MECHANICAL ENGINEER who would be interested in partnership in established business dealing largely in apparatus pertaining to economical production of steam, as recording instruments, steam meters, water meters, calorimeters for fuels and gases, etc. Headquarters New York. 736.

EDITORIAL ASSISTANT for technical paper. Location New York. Salary $30. 738.

YOUNG ENGINEER as salesman, for mechanical apparatus, forgings, castings, etc. Salary $25-$30. Location New York. 740.

ENGINEER for American plant in Hayti, to take charge of engines, boilers and pumps. Should be familiar with d-c. installation for lighting plant. Salary $150 to $175 per month. Will pay traveling expenses, board allowance, and after six months service entitled to return expenses. 742.

ASSISTANT ENGINEERS, familiar with power-station and factory-construction work. Location Connecticut. 743.

PRACTICAL MANUFACTURING EXECUTIVE, accustomed to supervising quantity production on modern basis, preferably of machine parts and stampings, and with some technical and construction experience; man from 30 to 35 years of age. Willing to join a large organization at salary of about $2000, as utility man and candidate for future position of more importance as opening arises. Location East. 746.

DRAFTSMAN familiar with thresher, gas and steam tractors. Give experience, age and salary desired. Location Ohio. 749.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, technically educated, twenty years experience in shop and drawing office, railroad and general contract engineering. Desires to make a change. Location immaterial. At present employed. Salary $2400. A-1

MECHANICAL ENGINEER. Twenty years experience in practical management of power-plant equipment: 15 years as executive. Broad experience with steam, electrical, hydraulic and refrigerating machinery. At present chief engineer and superintendent of maintenance for large industrial plant. Desires to connect with large concern wanting to improve conditions. Minimum salary $2500. A-2

ASSISTANT TO EXECUTIVE or EXPERIMENTAL ENGINEER. Stevens 1911 graduate; married; age 28. Possesses energy, initiative, self-confidence. Last three years in Middle-West in natural-gas transportation and measurement, including successful experimental work. Temporary engagement with U. S. Bureau of Mines about to end. Desires position with large industrial or engineering concern offering permanency and future. Initial salary not primary consideration. A-3

ASSISTANT MECHANICAL ENGINEER. Jun. Am. Soc. M. E., Cornell M.E. graduate; age 26. Has had considerable drafting-room experience, and at present employed with large coal-mining company but desires to make change. For last three years experience chiefly confined to power plants and testing power-plant equipment. Location preferred, New York. A-4

RAILWAY MECHANICAL ENGINEER, age 37, technical education, seventeen years experience, as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, railway-supply house or industrial plant, with greater responsibility and opportunity. Location immaterial. At present employed. Salary $2400. A-5

FUEL TESTING ENGINEER. Graduate; age 34. Seven and a half years experience in scientific testing of coal in industrial plants, for large coal company in Middle West. Desires position as combustion engineer for large user of coal. At present employed. A-6

SALES ENGINEER. Graduate. Experienced in scientific testing and selling of coal. Desires position as sales manager for coal-operating company. At present employed. A-7

CHIEF DRAFTSMAN or ASSISTANT SUPERINTENDENT. Technical graduate; age 36. Thirteen years experience. Familiar with manufacture of water-gas, soaps, leather belting, coal-mining and handling machinery. At present employed. Salary $1800 to $2400. A-8

DRAFTSMAN. Age 25. Three years technical training. Three years shop practice. Two years experience on design of appliances for installation of steam, gas, air, water and oil. Familiar with production work. Desires position with future. A-9

EXECUTIVE ENGINEER. Age 33. Ten years in responsible charge of important work; estimating, designing and constructing systems for the technical handling of all kinds of material in course of manufacture; six years in present position. A-10

ENGINEER OF TOOLS AND METHODS, SUPERVISOR OF PRODUCTION, CHIEF DRAFTSMAN or ASSISTANT SUPERINTENDENT. Member wishes to correspond with well-established concern. Wide experience in several of the largest and best-known concerns in this country and Europe, manufacturing small and medium-size accurate interchangeable parts, such as adding machines, typewriters, cash registers, watches and electrical mechanism. Natural mechanical and executive ability, together with broad experience in developing production of above work. Location, Chicago or vicinity preferred. A-11

WORKS MANAGER, SUPERINTENDENT or PLANT ENGINEER. Graduate mechanical engineer. Good organizer and executive. Extensive experience in the management of mechanical departments of railroad, coal-mining and industrial corporations; design, construction and management of large steam and electric power plants; design, construction, and maintenance of industrial plant buildings; reinforced concrete; design, installation, and maintenance of heavy and light steam, hydraulic and electrically driven machinery; management of shop, yard, office and drafting room forces. A-12

MECHANICAL ENGINEER. Technical graduate; age 26; two years experience operating and maintaining large power plant for industrial company and two years in efficiency, time-study and production end of same concern. Desires position with responsible future. Location New Jersey or Pennsylvania. A-13

MANAGER, WORKS MANAGER, or GENERAL SUPERINTENDENT. Technical education, M.E. Good executive abilities. Over 25 years abroad and varied experience in heavy, medium (electrical and metal-working), small and interchangeable work; thorough in modern methods, and practical along all departments, machine shop, smith, foundry, plating, japanning, wood-working, etc. Thoroughly capable in shop organization and supervision of manufacturing; qualified in office, buying, sales, cost, piece, bonus or premium methods. A-14

DESIGNING or CONSTRUCTING ENGINEER desires to change. Wide experience in power- and industrial-plant, pumping-station design and construction. Salary $4200 or salary and fees. A-15

ASSISTANT SUPERINTENDENT. Graduate M.E. Capable machinist. Familiar with scientific shop management and can produce results in handling men. A-16

MACHINE DESIGNER. Technical graduate. Seventeen years experience on centrifugal pumps, steam engines, steam pumps, elevating and conveying machinery, ball-bearing manufacture, roofing paper and paper machinery, factory equipment and maintenance. Now holding position as chief draftsman and engineer. Desires responsible position. Location Boston or vicinity preferred. A-17

MECHANICAL ENGINEER at present in executive position with large construction company, seeks connection with industrial or contracting concern near New York. Proven ability to handle general problems as well as details of technical or business nature. Familiarity with costs and prices qualify for position of responsibility. A-18

MECHANICAL ENGINEER. American; technical graduate 1902. Thoroughly familiar with manufacture and sale of high-grade engineering specialties. Factory experience in pattern, foundry, machine shop and drafting departments. Theoretical and practical experience of 16 years. A-19

HEATING AND VENTILATING ENGINEER. Age 35, married. Graduate M.E. from prominent university. Six years experience in estimating and designing heating and ventilating systems, covering wide range of installations. Desires permanent and responsible position. Available about January 1. A-20

CHIEF DRAFTSMAN, MECHANICAL ENGINEER, COMPETENT EXECUTIVE, systematic and reliable; has originality and initiative; 15 years experience. A-21

MECHANICAL ENGINEER. Jun.Am.Soc.M.E. Cornell graduate; age 28. Six years experience on power plant testing and supervision, and some selling experience. At present employed. Location preferred, New York or vicinity. A-22

TECHNICAL ENGINEERING EXECUTIVE. Age 34, married. Nine years practical experience as production engineer and executive. Good organizer, hustler, keen observer, energetic; has originality and initiative; up-to-date in costs, efficiency engineering, factory management, etc. Desires change with greater opportunities. Location immaterial, if healthy. A-23

MECHANICAL ENGINEER, MAINTENANCE ENGINEER, MASTER MECHANIC. Graduate; age 33; married. Thirteen years experience in Germany, England and United States, steam and electrical plants, heating and ventilating, factory layout and equipment, labor-saving devices, construction and maintenance, systematic. Desires permanent responsible post. A-24

WORKS MANAGER. Twenty years experience in manufacturing typewriters, firearms, automobiles and power-house equipment. A-25

EXPERIENCED ENGINEER on dies, jigs, fixtures and special machines for metal-working purposes is open for position. Chicago district preferred. A-26

MECHANICAL ENGINEER. Graduate from prominent university. Valuable and wide experience in shop, office and field both as subordinate and executive; five years in sales and consulting capacity with present connection. Desires responsible position in executive offices of good, live, progressive concern. A-27

MECHANICAL ENGINEER, ASSISTANT TO WORKS MANAGER or SUPERINTENDENT. Assoc-Mem.Am.Soc.M.E. Graduate Cornell University; age 31. Eight years experience in shop and drafting room. Accustomed to dealing with men. Aggressive, and eager for responsibility. Wishes larger opportunity than present position affords. Best references. Eastern states preferred. A-28

MECHANICAL ENGINEER. Age 33. Specialties: shop and power-plant construction, including installation of buildings, foundations, machinery and electrical apparatus; also crude-oil burning, valuation engineering and railroad mechanical engineering. A-29

TECHNICAL GRADUATE, eight years experience heat-treating, forging, testing and metallographic study of steel and brass. A-30

WORKS MANAGER or GENERAL SUPERINTENDENT. Age 40. High grade man open for new position. Able executive, good mechanic, with thorough practical knowledge of labor, production methods, planning and conditions necessary for economical factory management. Excellent past record. A-31

SUPERINTENDENT, SALES ENGINEER or ASSISTANT TO EXECUTIVE. Assoc-Mem.Am.Soc.M.E. Age 35. Fifteen years experience in manufacture and sale of electrical machinery. Desires change. Available upon 30 days notice. A-32

MECHANICAL ENGINEER or ASSISTANT SUPERINTENDENT. Assoc.-Mem.Am.Soc.M.E. Technical training, shop experience, 10 years of design and experimental work on gas, oil engines and air compressors. Able to ferret out and correct vexing problems about a shop, and estimate costs. Middle West preferred. A-33

EXECUTIVE, MANAGER IN ORGANIZATION WORK. Fellow A.I.E.E., Member of The Franklin Institute. Broad business experience and technical training; familiar with shop practice, cost, productive systems and sales engineering; operation of power wagons; also design, construction and purchase. A-34

ASSISTANT TO SALES MANAGER. Assoc-Mem.Am.Soc.M.E. Graduate M. E. Age 34, married. Desires position as assistant to executive or sales manager or as advertising manager. Several years advertising and editorial experience in power plant, mining and contracting fields. Very little actual selling experience. Good correspondent. Tactful. Accustomed to responsibility. East preferred. At present employed. A-35

MECHANICAL ENGINEER, graduating from well-known university in February, desires position with future. Any location. References and experience given. A-36

INDUSTRIAL ENGINEER Technical graduate, Junior Member; age 29. Three years' experience as designing draftsman of industrial plants, transmission machinery and labor-saving devices. Past two years industrial engineer, experienced on time-study work, scheduling, modern cost system, accounting, etc. Ability to increase production and decrease costs, standardize equipment and methods of manufacture. A-37

INDUSTRIAL ENGINEER Associate-Member. Pulp and paper mills (specialty newsprint). Fourteen years' experience in design, supervising, complete layouts, purchasing, construction, operating and maintenance. Executive capacity. A-38

GAS ENGINE ENGINEER. Technical man. Eight years' experience in design, development, and production of stationary engines and aeronautical motors. Desires position requiring unusual executive ability and judgment. A-39

ENGINEERING EXECUTIVE. Graduate M.E.; age 36; married. Good executive and organizer. General business training as executive in purchasing, selling and manufacturing departments, having filled positions of purchasing agent, branch sales manager, and plant manager, the latter for several years. Thoroughly familiar with modern manufacturing methods, efficiency systems and cost accounting. Prefers position which would ultimately lead to an officer and part owner or partner in the business. A-40

YOUNG ENGINEER, TECHNICAL GRADUATE, with two years' good engineering experience desires position as mechanical engineer or in engineering sales. At present employed. A-41.

MASTER MECHANIC OR CHIEF DRAFTSMAN. Ten years' experience in the manufacture of interchangeable parts. Thoroughly experienced in design of jigs, tools, fixtures and special automatic machinery for manufacturing parts on interchangeable basis to close limits. Location preferred in or in vicinity of New York or Newark, N. J. A-42.

ASSISTANT TO EXECUTIVE OR CONSULTING ENGINEER. Associate member, technical graduate, age 28. Ten years' practical experience, embracing machine and plate shops, drafting, inspecting, estimating, production and supervision. At present assistant superintendent of manufacturing plant employing 350. Location in vicinity of New York preferred. Salary $2000. A-43.

WORKS MANAGER, CHIEF ENGINEER OR GENERAL SUPERINTENDENT. American, 44 years of age, with 18 years' practical executive experience in the positions of chief draftsman, general superintendent and works manager on light and medium-heavy interchangeable parts as used on typewriters, moving-picture machines, gasoline and electric auto trucks, water meters, linotype machines, automatic machinery and machine tools, etc. Desires to make a change on or about May or June, 1917. For the past five years and at present successfully engaged as general superintendent with a manufacturing concern making machine tools. Desires to locate within a radius of 100 miles from New York City. A-1 systematizer, organizer and production man, with excellent executive ability, and can produce results. Best of references from past and present employers as to integrity, honesty and ability. Salary, $4000 per annum. A-44.

ENGINEER. Eighteen years' experience, covering shop management, sales and development work, principally in connection with pneumatic appliances. Seeks executive position. A-45.

INDUSTRIAL PLANT EXECUTIVE. General experience as engineer, purchasing agent, and cost accountant in large industrial plant. Available on short notice. Present location New York. A-46.

MANAGER. Mechanical Engineer, 35, technical graduate. Eleven years' thorough manufacturing experience in both office and shop, including sales and organizing cost, production, bonus and piece-rate departments, principally on light machinery, small tools and interchangeable parts. Can handle men successfully, lower costs and maintain quality. Salary $5000. A-47.

ENGINEER. Specialist and recognized expert in public-utility and industrial power work offers full or part time services to firm or corporation interested in such properties. Broad experience in the design, construction and operation of power systems and in making investigations, valuations and reports covering going and projected enterprises. A-48.

PRESENTATION OF THE JOHN FRITZ MEDAL

THE John Fritz Medal was presented to Prof. Elihu Thomson, eminent electrical engineer, for "achievements in electrical inventions, in electrical engineering, and in industrial development, and in scientific research," in the Central Hall of the Massachusetts Institute of Technology, on the evening of Friday, December 8, 1916.

The meeting was called to order by Prof. Albert Sauveur, Chairman of the John Fritz Medal Board of Award, and the program of the evening included addresses by John J. Carty, Chairman of the Presentation Committee of the John Fritz Medal Board of Award; E. W. Rice, Jr., President of the General Electric Company, and Dr. Richard C. Maclaurin, President of Massachusetts Institute of Technology. The presentation was made by Dr. Charles Warren Hunt, Past-Chairman of the Board of Award, and the ceremonies concluded with a response by Dr. Thomson.

ELIHU THOMSON

Mr. Carty reviewed the history of the John Fritz Medal, described the manner of awarding it and enumerated the distinguished men to whom this award has already been made.

Mr. Rice, a life-long friend of Professor Thomson, and with an intimate knowledge of his work, delivered a very interesting and forceful address. As emphasizing the magnitude of Professor Thomson's inventive work, Mr. Rice said:

"It would be impossible in the brief time at our disposal to adequately describe the achievements of our medalist in these various fields as it would involve describing the life work of one of the world's most prolific and industrious inventors and scientists. The impossibility of performing such a task can perhaps best be indicated by the statement that in the field of electrical inventions alone Profressor Thomson has been awarded something over 550 U. S. Patents, and in other fields, notably mechanical work, about 150 patents; that he has made contributions to the world's scientific and technical literature set forth in several hundred articles describing not only his own discoveries and inventions but making remarkably interesting contributions to scientific speculation and thought."

The speaker also gave testimony to the profundity of Professor Thomson's scientific knowledge:

"As a close observer of Professor Thomson's activities for over 36 years, I may be able to say something of interest as to his method of work. A skilled workman, he is always able to himself do the work which he asks others to perform. He prefers to make his own drawings, freehand sketches, to which he adds dimensions and a short written description. He selects his own materials, supervises the work, quickly makes such modifications as may be needed during its progress and stands constantly ready to give just the advice necessary to help over difficult places and turn failure into success. His inventions are the result of such profound and accurate knowledge and developed with such skill that they almost invariably work on the first trial in accordance with expectation. One of the most extraordinary things about his experimental work is its low cost. I am sure that if a prize were to be given for the inventor or engineer who could make a dollar go the furthest and produce the greatest results that Professor Thomson would have no worthy competitor in this or any other country. And I say this feelingly because I have had some experience with other inventors. He seems to possess an almost intuitive insight into Nature and her ways, probably because of the quickness and accuracy of his perception combined with the most remarkable depth and range of scientific knowledge, all helped by a marvellously retentive memory. In fact Professor Thomson perhaps more than any other inventor since the days of Henry or Faraday, combines in his person profound and accurate scientific knowledge with extraordinary technical skill."

Dr. Maclaurin characterized Dr. Thomson as an educational force of great potency and a man whose merits should, in the very highest interests of education, be widely appreciated and acclaimed. He gave an interesting conception of the mentality of such a man as Dr. Thomson:

"It has sometimes seemed to me that not the least significant fact in regard to Professor Thomson's work is the fact, known to those who have had the pleasure of seeing him in his home, that his laboratory is built right into the home and is an integral part of it. Probably thoughts on scientific problems are never wholly absent from his mind, although he may be consciously thinking of quite other matters. It can hardly be necessary to say that a man who has achieved what Thomson has done must be more than an unselfish, generous, well-trained, well-rounded, well-balanced man of science. Above all and pervading all must be imagination, not necessarily the imagination of a poet, but something akin to that in quality and in power, and it is of course mainly because Thomson is a man of imagination in the highest sense that he has achieved so much success and earned so much respect, not only in this country but throughout the scientific world. He has been literally showered with honors and it must be almost a unique thing to obtain two great national medals within almost a week, one from the Royal Society of London, and the other the great honor of the Fritz Medal that is now to be awarded. I heartily congratulate the Board of Awards on having found a man worthy to be placed beside the greatest whose names have already given distinction

to their selection like Graham Bell, Edison and Kelvin. Such a one undoubtedly is Elihu Thomson.

Past-Presidents Visiting China

DR. JOHN A. BRASHEAR, Mr. Ambrose Swasey and Mr. John R. Freeman, all past-presidents of The American Society of Mechanical Engineers, sailed from Vancouver on December 20 on an extended tour of the Orient to inspect engineering work there and also to enable Dr. Brashear to learn more about the educational system in that part of the world.

The tour is the climax of probably one of the most notable birthdays in the career of Dr. Brashear. On Wednesday, November 22, Pittsburgh friends of the Doctor planned a great public reception to him, and two days later "Brashear Day" was observed in that city and all Pittsburgh was given the opportunity of contributing to a fund for purchasing and endowing the old Brashear home and workshop in Holt Street. Commenting on the tour, the *Pittsburgh Sun* said editorially:

IT IS NEVER TOO LATE

Dr. John A. Brashear—and the name is enough of an introduction—will arrive at the 76th milepost on his journey through life on November 24th. This represents at least 70 years of activity, of dreams, of ambitions, of hopes realized and of disappointments that were unavoidable; of elation at success and depression at failure; of happiness and of sorrow. But through them all the beloved doctor has not allowed the big things to crowd out of his life the little ones, and by so doing he has retained constant interest in the things that have been going on around him. He has remained young in mind and body, and today he is physically and mentally more vigorous than two-thirds of those who claim a corresponding number of years.

But the point of this is that on his birthday Dr. Brashear will leave for a tour of the Orient. He will study the educational problem as it is presented in the Philippines, Japan and China. Accompanying him will be two well-known men, one skilled in Oriental affairs and the other, like the doctor, a maker of astronomical instruments. The tour outlined is a comprehensive one and will give the travelers a broad view of the Orient, and the exceptional opportunities for investigation that will be afforded them will be ample.

The action of Dr. Brashear in undertaking this long journey, principally for pleasure, to be sure, but also for study, affords the average individual food for thought. It is never too late to undertake anything that promises to redound to the benefit of humanity, no matter in how small a degree. Some persons might be inclined to think that after one has passed the Biblical span he is justified in taking a rest. But not so with energetic and youthful Dr. Brashear. He wants to know about the educational system of the Orient. What he sees there might result in an improvement in this country, and so he joins two congenial companions and starts. He will return even a better man than when he left because his mind will have become enriched by what he has seen and by the persons with whom he has talked and Pittsburgh will get the benefit. It is a wonderful thing to be able to carry 76 years as easily as does Dr. Brashear.

Mr. Swasey, in his characteristically painstaking manner, prepared in advance the complete itinerary of this tour, from the time of Dr. Brashear's leaving Pittsburgh on November 24 and his own departure from Cleveland on the same date, to the party's arrival back at San Francisco on April 2, 1917, after their journey to Yokohama, Kobe, Peking, Hankow, Nanking, Shanghai, and Hong Kong, and supplemented this with a map showing the route of the trip.

Mr. Freeman is accompanied by his two sons, John R. Freeman, Jr., a recent graduate in electrochemical engineering, and Hovey T. Freeman, a recent graduate in mechanical engineering from the Massachusetts Institute of Technology.

American Uniform Boiler Code Congress

THE work of the Boiler Code Committee received marked impetus from the action of the American Uniform Boiler Code Congress held at Washington, D. C., on Monday and Tuesday, December 4 and 5, 1916. The Congress was a gathering of representatives of various states interested in a uniform boiler code, which was called by the Industrial Commission of the State of Ohio, the body having charge of boiler regulation in that State. Representatives were sent by the Governors of 28 states, which, with the representatives of boiler-making, boiler insurance and other interests, numbered some 70-odd attendants. Hon. J. C. Callery, Chief Deputy, Division of Boiler Inspection, State of Ohio, presided.

The program began with an address by Hon. T. J. Duffy, member of the Industrial Commission of Ohio, who brought out forcibly the obligation of the Government to guard its citizens against the avoidable hazards of industry, pre-eminent of which is the use of magazines of energy like steam boilers, and the desirability of uniformity in the regulations adopted to this end.

He was followed by Dr. F. R. Hutton, Mem.Am.Soc.M.E., professor emeritus at Columbia University and vice-president of the American Museum of Safety, whose topic was Civilization and Government Are Based on Human Life; Protection of Life Is a Government's First Duty. Professor Hutton spoke of the importance to the mechanical engineer of safety considerations, and he showed how the mechanical engineer is best fitted to make provisions for the safety of the public. He alone can pass on the advantages or disadvantages of special constructions and his recommendations may safely be trusted. The mechanical engineer has become a leader whom we cannot afford to disregard, and safety standards proposed by him may be accepted as authentic.

The speaker stood "for the proposition that an industrial accident (and a boiler rupture or failure is such an accident) is an economic loss and an indefensible blunder from which the community has a right to be defended, and by ordinance or legislation." He showed that a boiler accident entails a loss in five different directions and explained that these are all capable of being expressed in dollars, aside from the bereavement in fatalities and the suffering inseparable from such disasters. From this he showed that the safeguarding of human life against boiler accident by legislation and ordinance is in line with progress and development, and he showed that scientific knowledge has advanced to a point where safety can be attained and that there remains only the question of proper legislative channels. Now the legislative and executive arms of the government should take hold with a strong hand to correct and remove the fatal conditions. It has been made clear that the facts and laws of applied science in respect to stresses and safety in pressure resisting vessels have been codified and recorded, and a way pointed out whereby uniformity of standard in the various states of the Union may be secured.

The second session opened with an address from Hon. P. J. McBride, Commissioner of Labor of Kansas, on The Protection of Labor as a Human Necessity and Its Effect on Business Economy. Mr. McBride emphasized the importance

of greater attention to the safety of boilers and their appurtenances as an element in the industrial development of the nation.

Next, Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., of Sheffield Scientific School, Yale University, spoke interestingly on Civil Service in the Department of Boiler Inspection. He pointed out the importance of absolutely divorcing this department from politics, and showed how the civil service could best handle the examinations and appointments of the boiler inspectors. He referred to the A.S.M.E. Boiler Code as a set of boiler-construction rules that should be generally applicable in all states, and he made a plea for uniformity throughout. He produced statistics showing that in 1914 there were in the whole German Empire 8 boiler explosions—the same number that Mr. McBride had just admitted having in the State of Kansas in 10 months. In the United States in the same year there were 575 explosions; in Germany the loss of life was 2, in the United States 30; in Germany the personal injuries 7, in the United States 476.

S. F. Jeter, Mem.Am.Soc.M.E., accredited representative of the State of Connecticut, read a letter from Governor Holcomb expressing his belief in the desirability of uniformity of laws covering similar commodities in different states and advising of his interest in the movement embraced in the Boiler Code Congress.

J. C. McCabe, Mem.Am.Soc.M.E., chief inspector of the City of Detroit, Mich., spoke on Realizations of a Uniform Boiler Code. He first showed clearly the hardship that is now imposed on both builders and purchasers of boilers by the numerous different codes and pointed out how necessary is this movement toward uniformity in construction codes. Mr. McCabe made a strong plea for a single uniform code, urged all states that have different codes to coöperate with the various states that have adopted, or are about to adopt, the A.S.M.E. Code, and announced that the State of Michigan would adopt that code this winter.

Mr. Callery announced that his State, which has in effect been working under two different boiler codes, is about to adopt the A.S.M.E. Boiler Code as its standard.

Hon. Victor T. Noonan, safety director of the Industrial Commission of Ohio, who was slated at the Tuesday morning session for an address on Some Interesting Aspects of Accident Prevention, was unable to be present and the time was occupied in general discussion. Thomas C. Eipper, deputy commissioiner of the Department of Labor of the State of New York and connected with the Bureau of Industrial Code, said that the bureau had the A.S.M.E. Code under favorable consideration. The possibility of Federal supervision of boilers transported from one state to another was suggested.

Henry Hess, chairman of the Standardization Committee of the A.S.M.E. and a member of the governing Council of that society, read a paper telling of the genesis and history of the A.S.M.E. Boiler Code. In Mr. Hess' address, the announcement was made that in the future, every state and municipality that adopts the A.S.M.E. Boiler Code shall be entitled to have a representative present at all meetings of the Boiler Code Committee.

Hon. Edward N. Hurley, chairman of the Federal Trade Commission, read a paper on Standardization as the Foreword of Business Efficiency. John A. Stevens, chairman of the Boiler-Code Committee of the A.S.M.E., told of the manner of production of the A.S.M.E. Code and the care which had been taken to have all interested parties have a voice in its formation.

The following resolution was unanimously adopted, only those having credentials from state or municipal executives being allowed to vote:

Whereas, Industry in every line of endeavor is very closely associated with steam as a motive power and the use of steam boilers; and

Whereas, Obtainable statsties covering a period of years show that in the United States there is annually a loss of from 400 to 500 lives and the disablement of from 1,000 to 3,000 people due to explosions of steam boilers; and

Whereas, The Government has recognized in the effort it has put forth in the safety movement that its first duty is the protection and safety of human life; and

Whereas, The Federal Government where it has the jurisdiction has prescribed rules for the construction of steam boilers; therefore, be it

Resolved, That it is the sense of this congress that all states should exercise supervision over the manufacture and use of steam boilers and all pressure vessels.

Mrs. Helen Adelaide Goldsmith (appointed by Mayor Gearon as delegate from Chicago) read an address commending the work of the A.S.M.E. and urging the yielding of the more sedentary occupations to the women, while the men occupy themselves with the more active work of the world. William F. Keisel, Jr., Mem.Am.Soc.M.E., assistant mechanical engineer, Pennsylvania R. R., said that the railroads had interested themselves in the framing of the Code and were in favor of its adoption. Reports were heard from committees on legislation, boiler codes, interchangeability of inspectors, etc., and resolution of thanks to the Ohio Industrial Commission and to Thomas E. Durban, chairman of the American Uniform Boiler Law Society were adopted.

Sixty-Ninth Meeting of A. A. A. S.

THE American Association for the Advancement of Science and the national scientific societies which have arisen from it and retain affiliation with it, have been important factors in encouraging scientific research and diffusing general interests in its results. The Association is organized in 12 sections covering the field of pure and applied sciences. Section D is the Engineering Section, of which Prof. A. H. Blanchard, of Columbia University, is Secretary. Our Society is affiliated with the Association and is represented on its Council by Dr. D. S. Jacobus and Mr. Wm. B. Jackson.

The Association held its sixty-ninth meeting in New York City from December 26 to 30, 1916. The membership of the Association at present numbers about 11,000, and it is believed that this meeting was the largest and most important gathering of scientific men hitherto held in this country or elsewhere. All the affiliated societies joined with the Association in this convention, and this year there were, including the sections of the Association, more than 50 separate national bodies meeting together.

Section D, Engineering, held a session in the Engineering Societies Building on the invitation of The American Society of Civil Engineers, The American Institute of Electrical Engineers, The American Institute of Mining Engineers and The American Society of Mechanical Engineers. At this meeting Dr. Bion J. Arnold gave the address of the retiring chairman and there were addresses by representatives of the national engineering societies, including President Hollis of our Society, followed by a reception to engineers and their associates.

Section D also held a joint session in the Assembly Hall of the Automobile Club of America with the National Highways Association, The Automobile Club of America, and the National Automobile Chamber of Commerce.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

ARRANGED IN THE ORDER OF THEIR APPEARANCE IN THE SURVEY.

SCIENTIFIC RESEARCH IN AERONAUTICS
AERONAUTICAL PROBLEMS
PROBLEMS CONCERNING AERONAUTICAL ENGINES
PHYSICS OF THE AIR
TRUCK AND TRACTOR ENGINES
PISTON DISPLACEMENT OF AMERICAN TRUCKS
WATER-PUMP CAPACITY FORMULA FOR TRUCKS
AUTOMOBILE PERFORMANCE FORMULÆ
RETARDATION IN MOTOR CARS
STOPPING TIMES AND DISTANCES OF CARS GOING AT VARIOUS SPEEDS UNDER BRAKING
TESTING STEEL BY ALTERNATING STRESSES
TESTING STEEL BY ROTATING BEAM METHOD
STEEL UNDER REVERSALS OF DIRECT STRESS
ANNEALING OF STEEL AND SMALL VARIATIONS IN TEMPERATURE
ANNEALING OF STEEL UNDER MAGNETIC FLUX
ELECTROMAGNETIC METHOD OF DETERMINING THE CRITICAL POINT OF IRON
ANNEALING OF STEEL, PHYSICAL PROPERTIES AND GRAIN SIZE
HEAT TREATMENT UNDER CENTRALIZED CONTROL
DETERMINATION OF FURNACE GAS MIXTURE BY BUNSEN TEST BURNERS
STRENGTH OF ASBESTOS ROPE EXPOSED TO FIRE
PROCESS OF COMBUSTION OF WOOD
CARBURETION AT HIGH ALTITUDES
SPARK-PLUG IGNITION
IGNITION AS RESULT OF IONIZATION
SPARK-PLUG EFFICIENCY AND ENGINE HORSEPOWER
INTERNAL-COMBUSTION TURBINE
FRICTION CLUTCHES
CRITICAL POINT OF SHAFTS
PRESSURE TESTS OF WELDED BOILER TUBE VESSELS
DOBLE STEAM MOTOR VEHICLE
DOBLE STEAM GENERATOR
SAFETY BURNERS FOR GAS-FIRED STEAM BOILERS
ENGINEERING SOCIETY
HIGH SPEED ENGINES
TRANSPARENCY OF PAPER AND TRACING CLOTH
SELECTED TITLES OF ENGINEERING ARTICLES
CHARTS

In this issue, Section Aeronautics, we publish a list given out by Lieut-Col. Geo. O. Squier, Aviation Service, War Department, U. S. A., embodying some of the problems connected with the development of military aviation and aerostation. This list is well worth attention, both because of its source and the evident carefulness with which it has been thought out.

The publication of this list is the beginning of an effort on the part of The Journal to cover the development of engineering research in the process of evolution, as distinct from abstracts of results previously published in other periodicals.

THIS MONTH'S ARTICLES

H. L. Horning compares truck and tractor engines, and discusses the characteristic curves of such engines, as well as the important but comparatively neglected subjects of water pumps and engine cooling.

Methods of comparing automobile performance are discussed by W. Fishleigh, who, among other things, presents a simple formula for the "automobile performance factor," which, the writer contends, affords a valuable comparison for cars.

In a paper before the Philadelphia Section of the S. A. E., John Younger, Mem.Am.Soc.M.E., presents the theory of retardation as applied to motor cars. In the discussion of this paper, the speaker made an important statement, viz., that the time is coming when local authorities will have to submit brakes to a regular system of inspection as a means of insuring the safety of travel on public roads.

In the Section Engineering Materials is reported a paper on testing steel by alternating stresses, the author using a method substantially different from that of Bauschinger. It appears to be possible to find the stress which a given sample of steel is capable of sustaining for an unlimited number of reversals without damage; this can be done by "statie" tests of the kind described, which have a further merit of quickness as compared with endurance tests carried to destruction.

In the same section will be found another paper on steel, this time on the annealing of carbon steels as affected by small changes of temperature and by magnetic fluxes acting separately or simultaneously. Among other things, the writer describes an electromagnetic method whereby the critical point of a piece of steel under heat treatment can be determined directly and accurately. This method, especially in the case of low-carbon steel, proved to be of higher sensitiveness than the thermoelectric method.

Modern methods of heat treatment as applied at an American plant are described in an abstract taken from *The Iron Trade Review*.

Data of tests on the tensile strength of asbestos rope when exposed to fire have been obtained experimentally in the mechanical laboratory of the Tomsk Institute of Technology, in Siberia, Russia. They show that on the whole, if used as life lines at fires, asbestos ropes present no material advantage as compared with ordinary hemp rope.

Some minute reactions in the combustion of wood are described by James Scott, whose investigations of similar reactions in the case of rusting of iron and paints on metal have been reported in previous issues.

That ignition of explosive gas mixtures by electric sparks is essentially a phenomenon of ionization, and does not depend exclusively on either temperature or voltage in the spark gap, is the contention of J. B. Morgan.

From *Power* is briefly abstracted the description of a new internal-combustion engine. Its cycle diagram is reproduced and explained.

In the section Mechanics will be found a brief reference to an article by Prof. A. Stodola on the critical speed of shafts. A more complete abstract of the same article will be given in an early issue.

Safety devices for preventing explosions in gas-firing installations on steam boilers are described from data published in a German periodical.

Aeronautics

SCIENTIFIC RESEARCH FOR NATIONAL DEFENSE AS ILLUSTRATED BY THE PROBLEMS OF AERONAUTICS, Lieut-Col. Geo. O. Squier

The following are some of the present problems connected with the development of Military Aviation and Aerostation.

I AERODYNAMICS

a Continue the development of the mathematical theory to explain the phenomena recorded in the aerodynamical laboratories, and to forecast further results.

b Obtain solutions for the speed and direction of flow of air about geometric and aerotechnic forms, and develop experimental means to visualize or map the speed and direction of flow.

c Map the currents of the upper atmosphere which may be of most use in aerial navigation, and evolve simple practical rules for the guidance of pilots.

d Give fuller explanation of the phenomena of soaring, i.e., aeroplaning indefinitely without motive power.

e Develop equations and laws of comparison by which the behavior of large aircraft may be more accurately foretold from tests of models. Apply further the principle of dynamical similarity.

f Investigate more direct and effective methods of securing a lift or thrust in the air from the consumption of fuel.

g Complete theory of the air screw.

II ENGINE PROBLEMS REQUIRING RESEARCH

a Fuel. Possibly the most far-reaching problem is fuel. A fuel that will carry more power into an engine per unit volume will be a direct gain.

Attempts have been made to combine alcohol, gasoline, acetylene, pieric acid, ether, and other hydrocarbons with the above object in view. Questionable results have followed. There has been an increase of power, but nothing so far commercially or practically useful.

This question must be studied with the greatest of care and from a truly research standpoint.

b Solid Fuel. Solid fuels that can be converted into liquid in small quantities just prior to use, are desirable for military aviation. In case of accident from shot or shock, leakage of liquid fuel is a danger. Solid fuel could be carried in quantity with less danger.

c Engine Cooling. The problem of radiation is important. If some substance could be found that would circulate through the cooling system, at higher temperatures than water, it is probable that greater engine efficiencies would result. Oils, salt waters and other materials have been tried with indifferent success.

d Liquid-Fuel Pipes. Tubing that will resist vibration (causing rupture) is desired. An oil- and gasoline-proof rubber tubing is reported as used in Europe. This development is highly important, not only for tubing, but for containers in which to carry liquid fuel. Some sort of fabric-and-rubber tank that would really resist the action of gasoline, would be of highest benefit.

A difficulty lies in the fact that the tanks are large (say 20 to 100 gal. capacity). The structural problems would be serious. The tanks now used are large and of metal. Vibration causes much difficulty and leakage.

e Metal Coating. The protecting of the metal parts of an aeroplane, especially the fittings and cables, is a serious problem. A material is desired that would really prevent dangerous corrosion. Nickel plating over copper is very good, but will not suffice. Rust strikes through very rapidly. Baked enamel is the best coating. It is impossible to apply in many cases.

f Sound. The question of eliminating the noises involved in the operation of aircraft is one of importance. The peculiar note of the propeller of a Zeppelin can be heard for several miles, and is usually the first warning of its approach at night.

III MISCELLANEOUS

a Physiological. Study the physiological and psychological effects of low-density air at high altitudes on the performance of pilots.

b Transparent Wing Covering for Aeroplanes. A wing covering which would answer the following general requirements would be of great value to military aviation:

Weight not more than 5 oz. per sq. yd. It should present reasonably great resistance to flame. It should be reasonably proof against action of salt water, moist air, extreme dryness, and quick temperature changes. It should not stretch in any direction. Its ability to retain original form as placed on the aeroplane is very important. It should have tensile strength of at least 75 lb. per in. width in any direction. Its tendency to tear and split because of tack holes through it, or because of bullet holes, should be as small as possible.

c Development of Light Alloys for Aeroplane Construction. Pure aluminum or aluminum alloys. It is believed that a great deal can be done in this direction. So far no alloy has been developed, except possibly in Germany, which can compare with average Alaskan spruce in its "specific tenacity."

d The Structure of Gusts. It is believed that this is of sufficient importance to aviation to warrant considerable expense in its study.

Painstaking investigation of the character of eddy formations caused when wind strikes trees, hollows, cliffs, etc., and the character of disturbances created by canyons, swamps, deserts, etc., would be of great value to aviators.

This can be done not only by smoke and toy-balloon work in the vicinity of obstructions such as the above, but also by photographic work in wind channels.

A set of simple rules laying down just what the aviator may expect on one side or another of canyons, cities, trees, lakes and swamps, would be very helpful in aviation.

e Radio-Apparatus for Aircraft. The subject of radio-intercommunication between aircraft in flight, and between aircraft and the earth, requires for its solution the highest possible efficiency and reliability combined with minimum weight.

A present tendency is to entirely separate the power plant from the main engine of an aircraft. The generator body in this case has a stream-line figure, and a separate small air screw is provided. Among other methods the oscillion is being tried as the actual source of continuous electromagnetic waves.

f Bullet-Proof Gasoline Tanks. Development of a material with which to line or construct tanks to contain the gasoline in an aeroplane in which a bullet hole will quickly close, entirely or partly at least. This would enable many a flier to beat back to his own lines after having been fired upon.

g Development of a Fabric as Good as, or Better than, Irish Linen, for the covering of aeroplanes. There has not

been manufactured in this country a fabric suitable for use in covering aeroplanes.

The fabric should answer all requirements laid down under Transparent Wing Covering, and be, in addition, such as to shrink the proper amount without harm when cellulose solution is applied.

It is possible that long-fiber cotton might be developed that would answer the purpose.

We must become independent in all lines affecting our military aviation. To-day we depend entirely upon Ireland and England for our linen, and the supply is becoming very low in this country.

h Aviator's Clothing. Much is still to be done in devising non-inflammable and protective clothing for aviators. This question is intimately connected with personal armor and safety in case of fall.

i Ground-Speed Indicator. An instrument which would measure the actual speed of an aircraft over the ground would be useful in the operation of military machines.

IV PHYSICS OF THE AIR

a High Frequency. At present we have no evidence of vibrations in the air much greater than 40,000 to 60,000 cycles per sec., but there is no reason to deny the possibility of vibrations of 100,000 to 200,000 or even a million cycles per sec. in the ordinary air we breathe. If these vibrations exist, may not they have an important function to perform in nature? The reason, of course, we do not perceive them, if present, is because they are above the upper limit of the human ear, and also do not directly affect any of our other senses. Although, in general, viscosity would operate to rapidly damp out these high vibrations, yet the real nature of viscosity at extremely high frequencies is not sufficiently understood at present to be dogmatic about it. The present efforts of the master physicists in the study of the constitution of matter should, before long, make the securing of high-frequency data in air of importance.

Electromagnetic waves of these frequencies existed through all time unperceived until Hertz devised a "detector." At present the detector for high-frequency air vibrations is the manometric flame, and it would be of great importance to invent a detector for air vibrations which would indicate their presence or absence up to 500,000 or a million per sec. If we had such a detector and also means for producing such vibrations in air, it would be possible to provide a system of intercommunication, over short distances at least, based upon ultra-audible sound waves. We could, for instance, devise a noiseless foghorn as an aid to navigation.

b Elasticity. The elasticity of the air has been made to serve in a great variety of machines to perform useful work. The original dynamite gun of Zalinski utilized the elasticity of compressed air as the explosive for propelling the projectile.

The best condensers for radio-telegraphy employ air as the dielectric. Any breakdown automatically repairs itself and thus adds greatly to reliability.

The passenger automobile itself has been made possible by the development of the pneumatic tire.

c Friction. The magnitude of the friction of the air against the surface of bodies moving through it may absorb large amount of energy. The average velocity of shooting stars is 25 miles per sec., and varies from 10 to 30 miles a second. The earth's orbital velocity is about 19 miles a second. It is sometimes added and sometimes subtracted from the shooting star's velocity according to the way the body enters the atmosphere. The friction of the air at these velocities is so great as to volatilize metals.

A mass of one gram of air moving with this velocity, 25 miles per sec., has a kinetic energy of 8.0937×10^{12} ergs, which is sufficient to lift one ton of matter, 2000 lb., to a height of 298 ft. above the earth's surface. One gram is a small amount of matter to possess this potentiality. This enables us to comprehend, in part at any rate, the disastrous results of the cyclone, where houses and forests are bodily cut down as by a giant steel knife.

d Mass. A cubic foot of air at 0 deg. cent. and 76 cm. pressure weighs 0.08071 lb., according to Rayleigh. A room $18 \times 20 \times 10$ ft. contains 3600 cu. ft. The air in it, therefore, weighs 290.556 lb. In liquid or solid form this air could be removed from the room with difficulty by a strong man.

On this view it appears that we have been passing our lives on the bottom of a deep ocean of comparatively heavy fluid, and that only recently have we learned how to utilize the dynamic reaction of this fluid to construct machines for transportation freely in three dimensions in the interior of this ocean. Who among us is wise enough to foretell what these machines may yet accomplish?

Automobiles

TRUCK AND TRACTOR ENGINES, H. L. Horning

Practically only four-cylinder engines are used in truck and tractor service. There are several important differences in the conditions under which truck and tractor engines operate. Trucks are stopped and started many times during the day and operate with considerable variation in speed. The tractor demands a steady though heavy output from the engine at approximately constant speed, the changes varying from half to full load or overload.

In the truck it is not essential to strain the dust in the carburetor or to pay particular attention to dust entering the breather, but in the tractor it is absolutely essential to see that every particle of dust is removed from the air as it enters the carburetor or breather, as carelessness in this respect results in worn rings, pistons, cylinders and bearings.

Truck engines have flywheels capable of storing an average or double energy of truck-engine flywheels in order to meet satisfactorily the sudden peak loads of service.

It should be borne in mind that a pleasure car will turn over 20,000,000 revolutions in traveling 10,000 miles; a truck engine 60,000,000 in traveling 14,000 miles, while during the period of six months a tractor engine will turn over 70,000,000 revolutions in plowing 600 acres and in doing some road and belt work.

Piston displacements of American truck engines have been found to conform to the formula

$$D = 200 + 40\,T$$

in which D is piston displacement in cubic inches and T nominal pay load in tons. An investigation of American truck engines indicates the ratio of bore to stroke as 1.3, therefore

$$D = 0.7854B^2 \times 1.3B \times N = 4.1\,B^3$$

$$B = \sqrt[3]{\frac{200 + 40\,T}{4.1}}$$

where B is bore of cylinder and N the number of cylinders, which is four.

Fig. 1 shows the characteristics of a well-known truck engine. This diagram shows that at three speeds in the curve peaks there occur, first, maximum torque at 783 r.p.m.; second, maximum horsepower at 1450 r.p.m., and third, maximum economy at 1044 r.p.m.

It would be ideal if these speeds were identical and if the truck engine could operate at all times at the one best speed. This is impossible, if only because of the influence of each characteristic on the other.

The speed of the maximum torque is established by the combined influence of cylinder cooling, flame propagation, volumetric efficiency, carburetion, compression leakage, and mechanical losses. At the speed of maximum torque the influence of cylinder walls on cooling the charge is on the decline. Turbulence of the charge and flame propagation are on the increase. Volumetric efficiency is dropping, while carburetion is improving with speed.

The speed of maximum economy, which is always higher than that of maximum torque, is established by favorable carburetion, by the better atomizing of the nozzle, increased flame propagation resulting from increased turbulence, and the good, although decreasing, volumetric efficiency. The time element as affecting the radiation losses and the decrease in the unfavorable influence of water-jacket temperature on economy and torque, seem to combine for favorable theromodynamic conditions at the speed of maximum economy. Of all the influences affecting economy, carburetor setting has the greatest actual effects. Of all the influences favoring torque, engine design has the most effect.

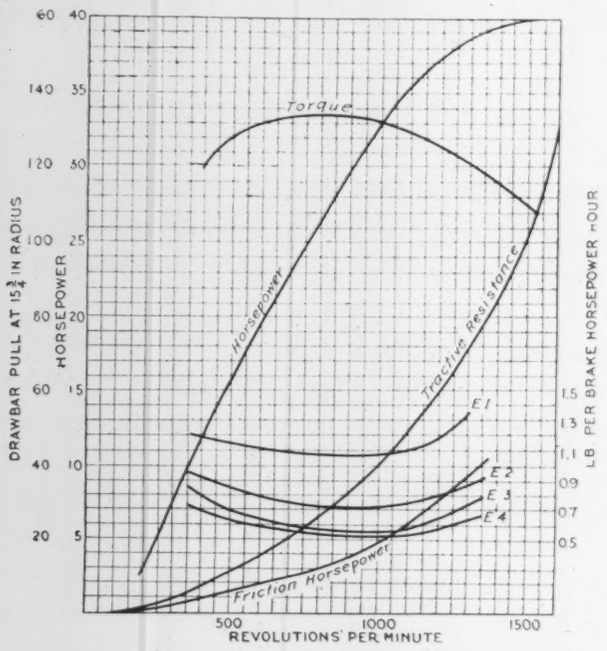


FIG. 1 CHARACTERISTICS OF TRUCK ENGINE

The speed of maximum horsepower is increased favorably by violent turbulence, low cylinder-wall-cooling losses, and by the declining volumetric efficiency and rapidly rising friction losses.

From this the author proceeds to presentation and discussion of truck- and tractor-engine specifications. An interesting passage is that referring to the water pumps and engine cooling, which latter the writer calls the greatest problem in tractor engines. Little reliable information is available as to water circulation or radiator capacity. A well-known company is making capacity tests of different radiators and fan designs for tractor service and these will soon be available. A rough rule for water-pump capacity is

$$G = \frac{BHP}{V}$$

in which G represents gal. per min. water-pump discharge through outlet to water jacket, and V is a variable dependent on engine and radiator design. For an efficient design it is 4.5, and for a poor design, 3.5.

The efficient lubrication of truck and tractor engines is second in difficulty only to that of racing engines. Successful lubrication of heavy-duty engines requires that oil make a film between wearing surfaces and act as a conveyor of heat. As the duty of an engine increases, it is hard to tell which is the more important function. The writer throughly believes in the great benefit derived from a large quantity of oil carrying the heat through the lower part of the cylinders and crank case into the lower pan, where the design should be such as to permit dissipation of this collected heat. An abundant screen area for thoroughly straining the oil is of great importance in heavy-duty work.

The writer discusses in detail the application of tractor engines and gives formulae for the tractor drawbar pull and for the speed of tractor engines in terms of the bore. (*S. A. E. Bulletin*, vol. 11, no. 1, p. 1, October 1916, 19 pp., 3 figs., *ct.*)

METHODS OF COMPARING AUTOMOBILE PERFORMANCE. Walter T. Fishleigh

The writer discusses the factors of automobile performance, and among other things states that automobile performance varies directly as S, the speed range in high gear in m.p.h., A, the average acceleration of car in ft. per sec. per sec. over the complete range of its operating speeds, E, the average fuel economy over the complete range of its operating speeds in miles per gal., and C, the riding comfort factor, which must be determined by each individual. The item C must be left to personal judgment, but the other items are each susceptible of scientific determination and measurement. The combination of these three factors S A E constitutes what the author calls the "automobile performance factor," which affords a valuable comparison for cars.

The writer discusses the determination of the performance factors as well as performance or ability formulæ other than the one proposed by him, such as the old ability formula, Pr/WD, and the vehicle coefficients of Myers, Roebuck, and Thomas. The Thomas Sigma formula among other things includes the average gasoline consumption in m.p.h., while the Brush ability formula represents excess drawbar pull per lb. of weight, and in this way gives an accurate measure of hill-climbing ability and the approximate measure of acceleration.

In the discussion which followed, Cornelius T. Myers expressed the belief that the factor of speed range is open to argument because as the speed is decreased the difficulty in obtaining satisfactory operation is increased. If the speed range is an essential factor which should be considered in direct proportion, the ratio of the high to low speeds should certainly be used.

C. C. Hinkley cited in a modified form the formula brought out by the Franklin Company. Divide the product of displacement in cu. in. and the gear ratio by the weight times the wheel diameter. If it is desired to introduce other factors, set a standard test of from 5 to 50 m.p.h.

$$\text{Ability} = \frac{\text{Displacement} \times \text{Gear Ratio}}{\text{Weight} \times WD \times t}$$

The quicker the acceleration from 5 to 50 m.p.h., the greater the ability.

E. Planche suggests that in order to make the automobile performance formula more precise, it be given the form $S\ A\ E/L$, where L is the lowest speed that can be maintained on high gear with the car running smoothly. (*S. A. E. Bulletin*, vol. 11, no. 2, p. 123, November 1916, 22 pp., 5 figs. *p*)

RETARDATION, John Younger, Mem.Am.Soc.M.E.

Paper read before the Pennsylvania Section of the Society of Automobile Engineers, November 22, 1916. The author is chief engineer of the Truck Department of the Pierce-Arrow Motor Car Corporation, Buffalo, N. Y.

During the past two or three years emphasis has been laid on the accelerative ability of cars, while the significance of retardation has not gripped the people's imagination, even though it is of more vital importance. The automobile death rate increases in inverse proportion to the efficiency of the retardation curve.

Retardation can be studied under two heads: *A*, relative to the road, and *B*, relative to the forces acting on the car. The primary object of the former is to slow down and actually stop the car. The object of the second is to maintain the vehicle at a steady, safe speed, notwithstanding the forces such as effect of gravity in hill climbing that are tending toward acceleration.

TABLE 1. STOPPING TIMES AND DISTANCES OF CARS GOING AT VARIOUS SPEEDS UNDER COMPLETE BRAKING.

	Stopping Time. Sec.	Stopping Distance. Ft.
A car going 60 m.p.h.	11	484
A car going 30 m.p.h.	5½	121
A car going 15 m.p.h.	2½	30¼
A car going 5 m.p.h.	0.625	4½

Retardation relative to the road is a function of the coefficient of adhesion or friction of the tire. The writer found an adhesion of 0.6 for solid rubber tires on cement and vitrified-brick roads, and only 0.5 under similar conditions for pneumatics. The author uses the term *adhesion* for the case where the tire does not slip relatively to the road. When the tire slips, the proper term is *friction*. As the coefficient of adhesion is greater than that of friction, this partly explains why the car stops more readily when the wheels are kept moving than when they are locked.

For possible retardation, the author gives a formula of retarding force, namely, $0.5\ W/2$, or a maximum retardation of about 8 ft. per sec. per sec. With this latter he obtains the data given in Table 1 for stopping time and stopping distance of cars going at various speeds. This table is of importance, as it disperses the claims frequently made of brakes being able to stop cars going at rates from 30 to 50 m.p.h. within the car's own length or thereabouts.

The discomfort produced by too rapid a deceleration is next discussed. Experience has shown that a deceleration of 6 ft. per sec. per sec. is about all that can be borne in comfort by passengers.

It is thus seen that for an average vehicle there is little to gain in putting brakes on more than the two rear wheels.

The question of continuous braking, such as on a long hill, is different, since here the problem is not inertia effect but absorption of energy, and hence reduction of heat. If a 5-ton truck, gross weight 20,000 lb., is going down a hill of 10 per cent grade a half-mile long, it has a gravitational component down hill of approximately 2000 lb. Assuming a road resistance of 50 lb. per 2000 lb., or 500 lb. gross, we have a net force tending to accelerate the truck down hill of 1500 lb. If a safe speed of 10 m.p.h. is maintained, the time of descent is 3 min. The energy absorbed by the brakes is 1500×2640 ft-lb. or 40 hp. or 1700 B.t.u. per mile, which means enough heat generated in 3 min. to raise the temperature of the mass from 60 deg. fahr. to 900 deg. fahr.

It is therefore the writer's impression that as the country roads get opened up more and trucks are used in outlying districts, the demand will arise for a third brake for hilly districts which will enable the vehicle to coast down a long incline at a predetermined safe speed with no wear and tear on the engine or undue heat of the brakes. (*The Automobile*, vol. 35, no. 22, p. 929, November 30, 1916, 3 pp. *tA*)

THE RESISTANCE OF IRON AND STEEL TO COMPLETE REVERSALS OF STRESS, W. C. Popplewell

A brief discussion of previous work in testing steel by alternating stresses, and description of three sets of experiments carried out by the writer himself.

An attempt was made to predict the limited stress for an unlimited number of direct reversals by the Bauschinger method of slow reversals, with two separate bars. Each of these bars was first subjected to ten slow reversals under specified stress, and then extensometer readings were taken in tension and compression to show the position of the elastic limits. The bars were than subjected to the same treatment, under successively higher loads in steps of ¼ ton.

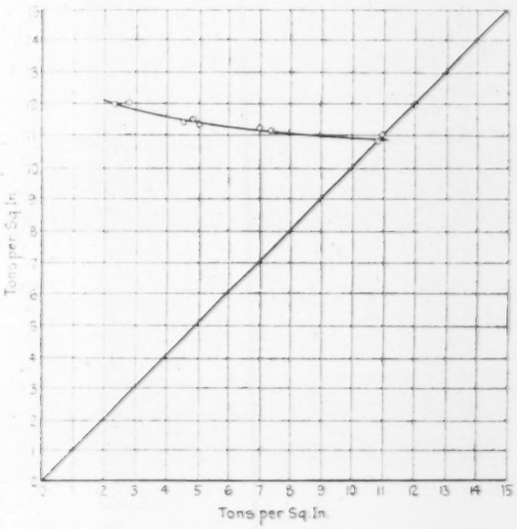


FIG. 2 DETERMINATION OF ELASTIC LIMIT BY SLOW REVERSALS

The results of these two sets are shown plotted in Fig. 2, from which it is seen that the line drawn to include the points of both bars cuts the 45 deg. line at the point just below 11 tons per sq. in., suggesting a limiting stress of not more than 11, or, say, 10¾ tons per sq. in., which corresponds to a range of 21½ tons per sq. in.

The second set of experiments comprised the *rotating-beam tests*. In these the bar under test was ¾ in. in diameter and ran in ball bearings 20 in. apart from center to center. The

force causing the bending moment was applied at two points toward the middle of the bar, 5 in. apart. This force was derived from a hanging rod through a pair of ball bearings attached to the ends of the cross-bar at the top of the rod carrying the load. The result was a constant bending moment in the 5-in. length in the middle, of magnitude $\frac{1}{2}W \times 7\frac{1}{2}$ in-lb., where W is the load. Any point in the middle 5 in. was subjected alternately to a tensile and a compressive stress each time the bar turned completely around, the value of these stresses being easy to calculate from the magnitude of the load. The speed of reversals was 350 per minute, which is lower than that employed in many cases of high-speed machinery in existence. It has been, however, proved before that for any speeds likely to be met with in running machinery the limiting stresses are independent of the speed.

The results of the rotating-beam experiments are shown in Fig. 3, where the applied stresses are plotted vertically and the number of reversals necessary to cause fracture, horizontally, the result being a curve which tends to become tangential to a line drawn through a stress, which is taken as the value for an unlimited number of reversals. In this case the limiting stress suggested by the direction of the curve appears to be somewhere about 19.6 tons per sq. in., or through a complete range of 39.2 tons per sq. in.

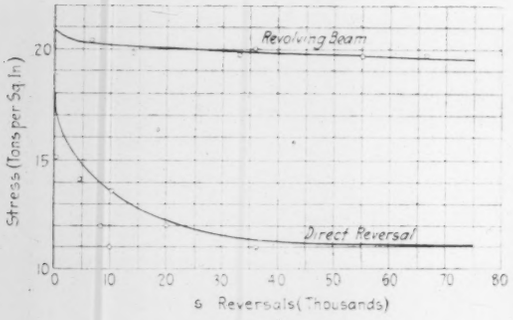


FIG. 3 ROTATING-BEAM TESTS

For *experiments under reversals of direct stress* was used a combination of a reciprocating movement and the deflection of a flat spring. The former was derived from the movement in a milling-machine attachment, there being in this an eccentric with a throw of $\frac{3}{8}$ in., giving a reciprocating movement to a slide block through a connecting rod 2.5 in. long.

The end of the slide block further from the eccentric has a continuation into which the end of the specimen under test is screwed, so that, as the shaft carrying the eccentric revolves, one end of the specimen is reciprocating through $\frac{3}{8}$ in. on either side of its central position, the other end of the specimen being screwed into a holder which forms part of a clamp gripping the middle of the spring. This spring has a span of 14 in., its ends passing between supports which prevent movement in either direction.

When the machine is running and the point of attachment of the connecting rod with the sliding piece is in its mid-position, the spring is in a state of ease and there is no force applied to the specimen. But when the slide reaches its extreme position on the side further from the spring, the latter will have been deflected from its central position through $\frac{3}{8}$ in. by a force in tension applied through the specimen. The net result is that during one revolution of the shaft the specimen is subjected to a complete cycle of stresses proceeding from a maximum in tension through zero to a maximum in compression and back again. This spring is made of 7 plates, each 0.075 in. thick and 2.25 in. wide, and it was found from experiment that a load of 110 lb. is required to deflect the spring through $\frac{3}{8}$ in. on either side of its central position.

In order to simplify the experiment it was found convenient to vary the stress by changing the diameters of succeeding specimens, and with them the areas of their cross-sections.

The results obtained are plotted in Fig. B, where it is seen that the curve tends to become horizontal at a stress of 11 tons per sq. in.

The results obtained by the writer are tabulated in Table 2. Among other things it has been found that the actual form of the part of the rotating beam which carries the greatest stress has considerable influence on the numerical values of the results. It has been further found that, apparently, it is possible to find the stress which a given sample of steel is capable of sustaining for an unlimited number of reversals without damage, and that this can be done by "statie" tests of the nature described above.

This plan has the advantage that an ordinary testing machine can be used, capable of exerting both tensile and compressive loads, and has the further merit of quickness as compared with endurance tests carried to destruction. (*The Engineering Review*, vol. 30, no. 4, p. 120, Oct. 16, 1916, 3 pp., 8 figs. *e*)

TABLE 2. RESISTANCE OF STEEL TO COMPLETE REVERSALS OF STRESS

Material	Primitive Limit	Yield Point	Tensile Strength	Range of Stress		
				Static	Rotating Beams	Direct
Steel Forging (The Writer. Former Experiments)	12.50	14.0	28.56	18.4	24.4	
Steel Forging (Stanton & Bairstow)	12.94	14.52	29.47	....	....	20.60
Steel Forging (Present Experiments)	10.0	14.0	25.4	21.5	39.2	22.0
Cast Steel (Writer)	22.24	....	55.70	40.50	44.8	....

THE ANNEALING OF CARBON STEELS AS AFFECTED BY VARIOUS TEMPERATURES AND MAGNETIC FLUXES, R. B. Fehr

Data of tests carried out at the Engineering Experiment Station, Pennsylvania State College, State College, Pa., with the primary object of studying the range of temperature in which the various steel heat-treating operations should be carried out.

The writer has been unable to find in published form any series of tests that would show the variation in physical properties due to small variations in temperature throughout the critical range. As usually the temperature is varied by 50 deg. cent. intervals, it would be of interest to find the effect of small temperature variations, with the object of determining what advantages could be derived from better temperature control.

In the same series of tests an attempt has been made to determine whether there was any unusual effect on the physical properties of steel from being subjected to heat treatment and the action of magnetic flux simultaneously. It was believed that, as heat brings iron and steel into a mobile condition, magnetic flux in connection with heat might facilitate this rearrangement of the structure, and thus help to bring about a more complete transformation, with a consequent beneficial effect on the physical properties.

At temperatures above 750 deg. cent., iron and steel are practically non-magnetic, and therefore cannot be affected by magnetism; but when steel cools below this temperature and regains its magnetic properties, it may be that magnetism might have some good effect if induced in the metal during the process of cooling past the magnetic critical point. The chances are that alternating currents would give the best result on account of the constant shaking or vibration of the molecules.

Among other things, the writer made a determination of the critical point of iron, with the result that an electromagnetic method was evolved, whereby the critical point of a piece of steel under heat treatment would be determined directly and accurately. This method depends upon the loss of magnetic properties of steel at a critical temperature, and upon electromagnetic induction. The writer describes the method and apparatus in detail. Essentially, an electromagnet was placed around the heating furnace in such a way that the magnetic circuit was completed through the piece of steel undergoing heat treatment, but, instead of placing the coil about the heated part, the writer located it outside the furnace, in such a position, with respect to the magnetic field, that the sudden change of residual magnetism at the critical point would be made use of. This change of residual magnetism was indicated very sharply on a millivoltmeter by breaking the electromagnetic circuit.

In order to obtain a strong magnetic flux which would be exerted on the bars at the same time that they were undergoing heat treatment, the field of an old Manchester bipolar, series-wound dynamo was set up on end with the end yokes removed.

The two steel rods under test served to complete the magnetic circuit. The magnetic field due to a few amperes was exceedingly strong, and the flux density was considerably beyond the knee of the saturation curve for every grade of steel tested.

In the determination of the critical point the method of procedure was to break the field circuit at regular intervals during the heating and cooling processes.

The tests were run on 0.04, 0.28, and 0.835 per cent carbon steel, ¾-in. round bars.

Several tests showed quite conclusively that the electromagnetic method of obtaining the critical temperature gave practically the same result with high-carbon steel as the thermoelectric method, but that with low-carbon steels the thermoelectric method was not sufficiently sensitive, which may be due to the fact that in these steels there are really three distinct critical points, each of which is characterized by only relatively slight evolutions of heat.

The results are given in the form of tables and curves. In particular, with 0.04 per cent carbon steels, the elastic limit of the rolled bar was decreased about 6000 lb. per sq. in. by the annealing treatments, but otherwise the curves of the plotted results (Fig. 4) show practically no change in the physical properties due either to annealing temperature, or to treatment with magnetic flux, except in the case of the elongation, which shows a slight jog just above the magnetic critical point. These results are therefore entirely in accord with the

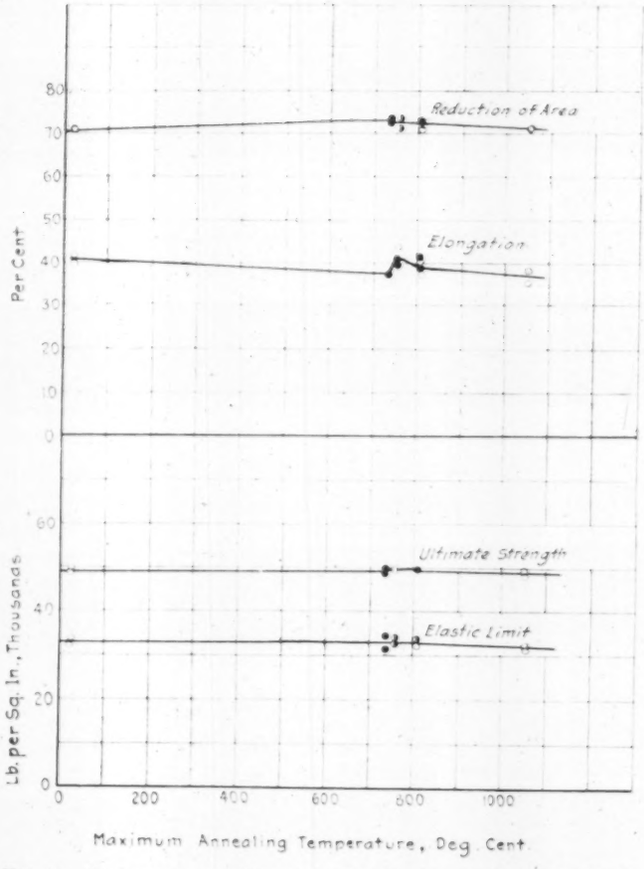


FIG. 4 VARIATION OF PHYSICAL PROPERTIES WITH ANNEALING TEMPERATURE, 0.04% CARBON STEEL

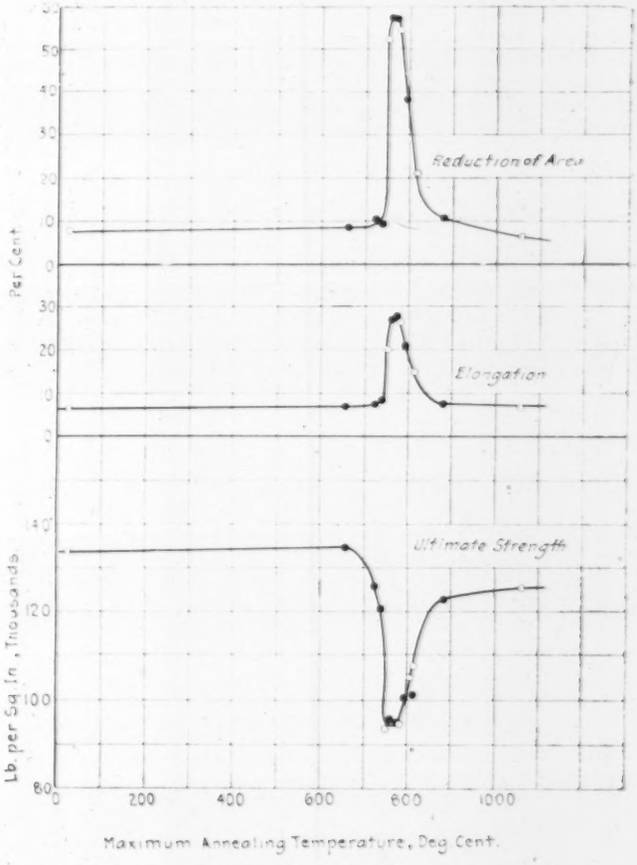


FIG. 5 VARIATION OF PHYSICAL PROPERTIES WITH ANNEALING TEMPERATURE, 0.835% CARBON STEEL

known fact that low-carbon steels are very little affected by heat treatment.

The results of this series of tests with 0.28 per cent carbon steels show that the annealing temperatures around the magnetic critical point have considerable effect on the physical properties, especially the elongation and reduction of area. In raising the annealing temperature from 740 deg. cent. to 761 deg. cent. the elongation was suddenly increased 22 per cent, and the reduction of area 20 per cent, both of these properties falling off gradually to their former values at the temperature of about 880 deg. cent.

Finally, tests on 0.835 per cent carbon steels show (Fig. 5) the remarkable effects which the small variation in the annealing temperature has upon the physical properties of a high-carbon steel. Simultaneous treatment with magnetic flux did not appear to have any effect whatsoever. The author calls attention to the fact that the range of annealing temperatures recommended for this grade of steel was between 790 and 815 deg. cent., which would not have brought about maximum ductility or reduction of area, as shown by the tests.

The writer found that in all his tests the magnetic critical point indicated without exception the proper annealing temperature to give the finest grain, maximum ductility and reduction of area, and therefore the maximum shock-resisting qualities. This temperature in all cases lies within a range of 30 deg. cent. just above this critical point. It was found that, by careful temperature control, a high-carbon steel can be given the ductility of a low-carbon steel, and at the same time possess a higher elastic limit and ultimate strength than are to be found in low-carbon steels.

The experiments showed that in the annealing of carbon steels the ductility and reduction of area increase as the grain size decreases, but that the tensile strength and elastic limit decrease with decrease of grain size.

The results obtained by this investigation apply, as the author points out, only to the annealing of carbon steels. (*Abstract from advance copy of a paper to appear as Bulletin No. 18 of the Engineering Experiment Station, Pennsylvania State College*, State College, Pa. *e*).

MODERN IDEAS IN HEAT TREATMENT

Description of the methods used at the plant of the Steel Products Company, Cleveland, O., having for their purpose the elimination of variations in the quantity of heat-treated products.

The output of the Steel Products Company consists largely of automobile-motor valves, poppet valves, spring-shackle and steering-knuckle bolts and valve tappets, made of both common and alloy steel, demanding the best of heat treatment.

The uniformity of results is being secured here by maintaining a uniform quality in the gas supplied to the furnaces, which again involves the thorough mixing of scientifically predetermined proportions of gas and air. The mixture is distributed to the furnaces under a constant pressure, which is maintained by a constant-speed centrifugal fan located between the mixer and the furnaces. The gas-mixing apparatus developed by German engineers is based primarily upon the idea of mixing gas and air at the same pressure. This feature of equalizing the pressure of the gas and the air is essential if the proportions of each are to be accurately controlled, this control being accomplished by a counterbalanced gas governor into which the gas is received as it flows into the mixer from the gas meter. The governor is shown to the right in Fig. 6. The air is mixed at atmospheric pressure, with the gas entering from the gas governor. After leaving the mixer, the mixture is forced through the pipes to the different furnaces by a 15-hp. constant-speed centrifugal pump, which maintains a constant pressure regardless of the amount of the mixture being consumed.

As the mixture of gas and air in the proportions to produce perfect combustion is explosive, only part of the air necessary to insure this perfect combustion is taken in through the machine. The remainder is added to the burner itself by means of a Bunsen attachment.

The proper mixture for each installation is determined with the aid of a test Bunsen burner. These test burners operate on the principle that the height of the combustion cone is related to the pressure and proportions in which air and gas are mixed. With this system, only enough air is supplied to the burners to insure proper combustion, which results in a material economy of gas.

An interesting feature of this plant is the system of centralized control of furnaces. The gas from the pump is piped to the operator's house. Valves located in this house lead to the furnaces. Because of the fact that the gas is supplied to the furnaces through a single pipe for each furnace and because the mixture of gas and air is adjusted before it passes

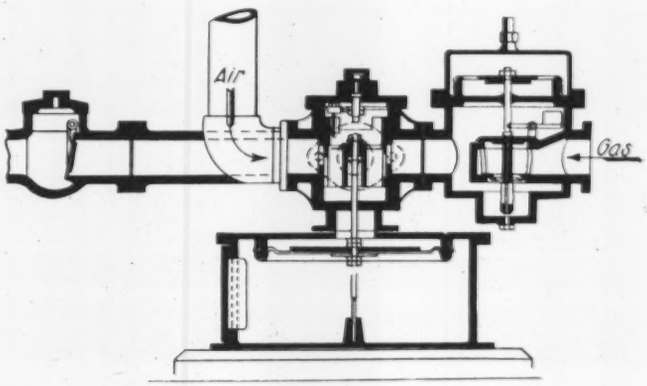


FIG. 6 COUNTERBALANCED GAS GOVERNOR FOR HEAT-TREATING FURNACES

through the regulating valves, a pyrometer man is enabled to regulate the temperature of each furnace separately from his control board. The test burner and pressure gage located in the operator's house not only serve to indicate if the pressure and quality of the gas are being maintained as desired, but also serve to indicate the cause of trouble in case of accident to the mixer or pump. Furnace temperatures are indicated in the control house by pyrometers. (*The Iron Trade Review*, vol. 59, no. 21, p. 1047, November 23, 1916, 4 pp., 5 figs. *dp*)

THE TENSILE STRENGTH OF ASBESTOS ROPE WHEN EXPOSED TO FIRE, J. Bobaricoff and W. Mramornoff

As it has been suggested that asbestos ropes might prove serviceable as life lines at fires, the writers have investigated the strength of such ropes under conditions similar to those which they would have to meet if so used.

A. F. Cirkel has tested asbestos ropes having a core of other material. He states that a rope of this kind ½ in. in diameter was good for 200 lb.

The ropes tested in the present instance were three in number—two of asbestos and one of hemp. The larger of the two

asbestos ropes, No. 1 was 1 in. in diameter and was built up of $4 \times 4 \times 4 \times 3 \times 3 = 576$ primary yarns. No. 2 rope, also of asbestos throughout, had $3 \times 3 \times 3 \times 3 \times 3 = 243$ primary yarns, while No. 3, the hemp rope, consisted of $7 \times 3 \times 3 = 63$ yarns. None of the ropes had a core of other material. The asbestos used was chrysotile from the Urals and had a hygroscopic water content ranging from 1.1 to 1.2 per cent at 18 deg. cent. with the air at 50 per cent humidity.

The first series of tests was made with the ropes in condition as received. As the ropes for use in fires would be liable to be wetted, it was also considered of interest to test asbestos ropes after three days' immersion in water. It was found that rope No. 1 lost 12.3 per cent of its strength and rope No. 2, 4.4 per cent.

A further series of tests was made on strands unwound from the ropes heated to different temperatures in a Heraeus electric furnace. The maximum temperatures reached were maintained for 3 hours in every case. The results are shown in Table 3, and indicate clearly that the strength diminishes

TABLE 3. TESTS OF STRENGTH OF HEATED ASBESTOS ROPE

Temperature of furnace. Deg. C.	Condition of test.	Breaking load. Kg.	Absolute. Kg.	Loss of strength.—Compared with unheated strand. Per cent.	Loss of strength.—Compared with merely cooled strand. Per cent.
	Unheated	85.0	...	...	...
220	Cooled after heating	87.5	2.5	2.9	...
220	Wetted after cooling	64.0	21.0	24.7	27.0
	Unheated	80.0	...	...	...
270	Cooled after heating	72.8	7.2	9.0	...
270	Wetted after cooling	53.5	26.5	33.1	26.5
	Unheated	73.0	...	...	...
360	Cooled after heating	54.8	18.2	24.8	...
360	Wetted after cooling	42.5	30.5	41.8	22.5
	Unheated	85.0	...	...	...
400	Cooled after heating	66.3	18.7	22.0	...
	Unheated	72.8	...	...	...
500	Cooled after heating	54.0	18.8	25.8	...

TABLE 4. EFFECT OF REPEATED HEATING ON THE STRENGTH OF ASBESTOS ROPE

	Breaking load. kg.	Loss. per cent.
Temperature 140 deg. cent.	119	15
Temperature 210 deg. cent.	29.6	81.5

very rapidly as the temperature of each rope heated is increased. The next series of tests was made on specimens first heated and then immediately cooled down again as soon as the limit temperature was reached. It was found that the loss in strength was increased by prolonged heating.

To see the reason for this loss of strength on heating, a determination was made of the loss of weight when the asbestos was heated for three hours in the electric furnace and allowed to cool in a desiccator. It was found that the loss rapidly increases after a temperature of 550 deg. cent. is reached.

On the whole it was found that loss of strength and loss of weight for the most part ran together, but that if the maximum temperature does not exceed 299 deg., this rule fails. The rapid loss in the resistance occurs at a somewhat lower temperature than the corresponding rapid loss in weight. This is apparently due to the heat destroying the cohesiveness of the constituents somewhat sooner than it is able to expel the products of decomposition.

The large loss both in strength and weight between 200 and 350 deg. cent. is due to the burning out of the organic matter.

Tests were made on strands heated in the furnace and loaded at the same time. The temperature was raised until the strand broke. In the first series the strand was loaded with a weight of 30 kg., and broke when the temperature reached 650 deg. cent. The same strand unheated showed a resistance of 70.5 kg.; heated and cooled, 39 kg.

Some additional experiments were made on the effect of repeated heatings followed by cooling in water. A number of specimens were first raised three times to 400 deg. cent., cooled twice, and then broken. It was found that repetitions of the heating process have relatively little effect on the strength. For purposes of comparison some tests were also made on the effect of temperature on the strength of the hemp rope No. 3, with the result shown in Table 4.

On the whole the tests indicate that asbestos ropes such as tested in this case cannot be considered as suitable for use as life-lines at fires. Similar ropes with steel cores would be stronger, but the asbestos would then serve merely as a heat insulator, for which purpose it is not very well adapted, as it becomes very brittle at a temperature of 600 deg. cent.

All these tests were carried out in the mechanical laboratory of the Tomsk Institute of Technology, in Siberia, Russia. (*Engineering*, vol. 102, no. 2654, p. 451, Nov. 10, 1916, 2 pp., *e*)

THE COMBUSTION AND FIREPROOFING OF WOOD: SOME MINUTE REACTIONS, James Scott

The writer discusses the process of combustion of wood on the basis of some experiments made by him on pine shavings.

He laid a thin shaving, about 1 in. long and ¼ in. wide, upon a glass slide, with nearly half of it projecting beyond the edge. This free part was then ignited, and when it had finished burning there remained the suspended white ash, the shape of which would be easily discerned by transferring the slide carefully to the stage of the microscope. It was then observable as a fine, delicate skeleton framework of the destroyed cells.

A glowing ember of wood affords a wonderful spectacle under the microscope, where one can see the flare traveling among the cells, charring them and leaving an ashy trellis-work of disclosed walls.

In the test with the pine shaving partly under the glass slide, one can distinguish the gradation from one condition to another in the process of burning. The heat, while consuming one area, liquefies the cell contents in the vicinity and drives some of them further away in the opposite direction, thereby expanding and bursting the cells and discharging from them gases which feed the oncoming fire.

Fig. 7 shows, on a dark background, a small portion of the burned shaving, wherein all phases from intact to destroyed wood are visible.

When wood is burning and water is played upon it, the main result, according to the view of the author, depends, first, on the mineral matter contained in the water, and, second, on the mineral ash released from the already consumed substance. Hence, he believes that purposely made hard water containing, say, excess lime, would check the progress of the flames at a quicker rate than would be the case with distilled water.

When wood is burning the fundamental carbon is given off as myriads of infinitesimal specks, and if it be allowed to rise onto a glass slide it shows remarkable patterns due to a particular arrangement of the particles. In Fig. 8 is shown the filigree occasioned in a thin, gray layer of wood smoke, the carbon molecules evidently having been contained in gaseous or semi-vaporous globules, which, on meeting the solid glass, subside so that their walls produce rings and their contents central nuclei of various forms. Some of the soot is found as shining, tarry films, and the rest as a lusterless powder. (*The Railway Engineer*, vol. 37, no. 442, p. 261, November 1916, 3 pp., 3 figs. *e*)

Internal-Combustion Engineering

CARBURETION AT HIGH ALTITUDES

Symposium of Answers of Various Carburetor Manufacturers to an Inquiry on the Above Subject

C. W. Findeisen states that if the carburetor has been carefully adjusted at lower altitudes and shipped to high altitudes, it is necessary to cut down the supply of gasoline to some extent.

G. T. Briggs, of the Wheeler & Schebler, Inc., states that in their Model L carburetor it was found necessary for high-altitude work to change the adjustment—that is, to turn on a little more gasoline at the needle and use a weaker spring. It was found that turning on more gasoline did not change the fuel combustion, owing to the rarity of the air. The Model R carburetor works well without changing the adjustment at high altitude, although a change will decrease the consumption. The experience of this company is that in order to get satisfactory results a little more gas must be supplied, also the spring must be changed in order to get more air into the carburetor through the auxiliary valve. This is due to the fact that the suction is much lower at the higher altitudes. If no change in adjustment is made, the carburetion is bad and the fuel combustion high at over 5000 ft. elevation.

Arthur B. Browne, of the Malleable Iron Fittings Company, in discussing the theory of carburetion at high altitudes, calls attention to the fact that the mean effective pressure of the engine is a function of the compression pressure. An engine having 70 lb. per sq. in. compression in New York should have a mean effective pressure of about 91 lb. per sq. in.; in Butte, which is at an elevation of nearly 6000 ft., this same engine would give a mean effective pressure of only about 81 lb. per sq. in., as a result of the lowered compression only. Hence a truck engine developing 40 hp. in New York, would develop but a little over 35 hp. in Butte if supplied in both cases with the same mixture. The loss would in fact be even greater because of a slower flame propagation in the mixture at lower compression and other considerations, while the decreased negative work of compression would be a factor on the other side.

The author makes the following practical suggestions: (1) Reduce the gas in the carburetor and the adjustments at all speeds as accurately as the instrument will permit; (2) advance the spark as far as possible; in fact, until the engine gives a sharp knock, when it should be retarded until the knocking ceases; (3) remove the governor or at least set it much faster than usual.

According to F. C. Mock, of the Stromberg Motor Devices Co., the rareness of the air decreases the relative opening of weight- or spring-control air valves. This is taken care of by using larger primary openings and lighter springs. The change in mixture proportion is only a small part of the difficulty, as the heat-up of the engine makes its operation uneconomical.

Geo. M. Holley, of Holley Bros. Co., states that his company has adjusted carburetors at Kenosha, Wis., on Rambler cars, and shipped them to Denver, Colo., which is at an altitude of 5000 ft., but could find absolutely no difference in the operation of the device.

In this connection it may be of interest to compare the experiences with Diesel engines at high altitudes described in

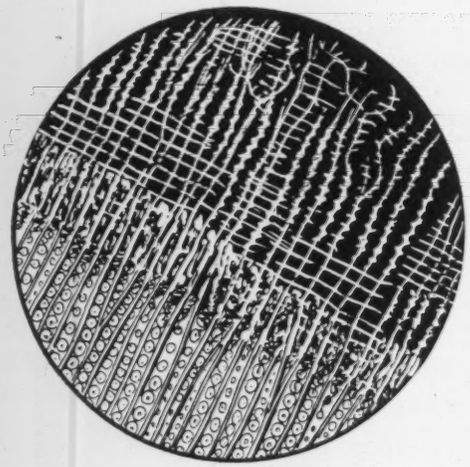


FIG. 7 MAGNIFIED VIEW OF PINE SHAVING, THE UPPER PART OF WHICH HAS BEEN BURNED TO AN ASH, WITH AN INTERMEDIATE CHARRED ZONE. DIAMETER OF SPACE ABOUT 1/24 IN.

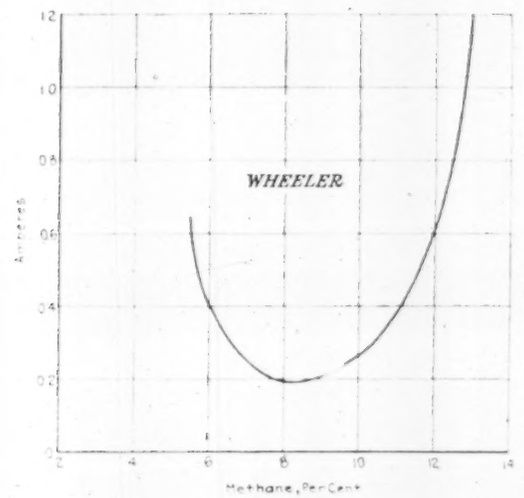
FIG. 8 MAGNIFIED VIEW OF FILM OF CARBON FROM THE BURNT PINE SHAVING. ACTUAL DIAMETER OF THE SPACE ABOUT 1/24 IN.

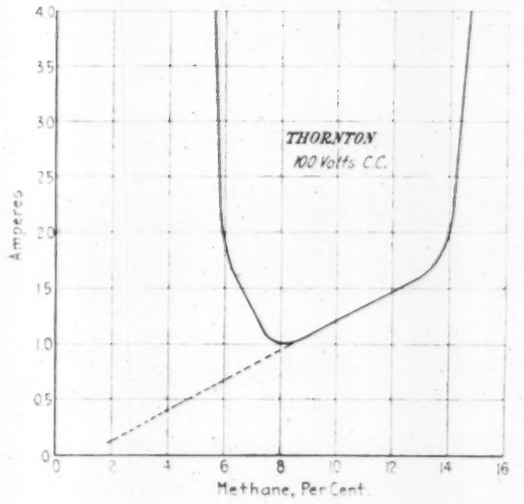
The Journal, October, 1916, p. 833. (*S. A. E. Bulletin*, vol. 11, no. 1, pt, Oct. 1916, 3 pp, *p*)

IGNITION OF EXPLOSIVE GAS MIXTURES BY ELECTRIC SPARKS, J. D. Morgan

The ignition of an explosive gas mixture by a spark is commonly considered to depend upon the communication of heat from the spark to the gas, but experimental investigation tends to indicate that ignition depends, at least partly, and perhaps entirely, upon some other cause than this. It does not seem likely either that temperature is the determining factor in ignition, because it is known that if the temperature is not accompanied by a sufficient quantity of heat, ignition will not occur.

Further, if it be assumed that heat alone, when accompanied by sufficient temperature, is capable of causing ignition, it would apparently be right to suppose that the mode of producing electric sparks containing sufficient heat would have no effect upon the igniting property of such sparks, which again is found not to be the case. For example, Prof.





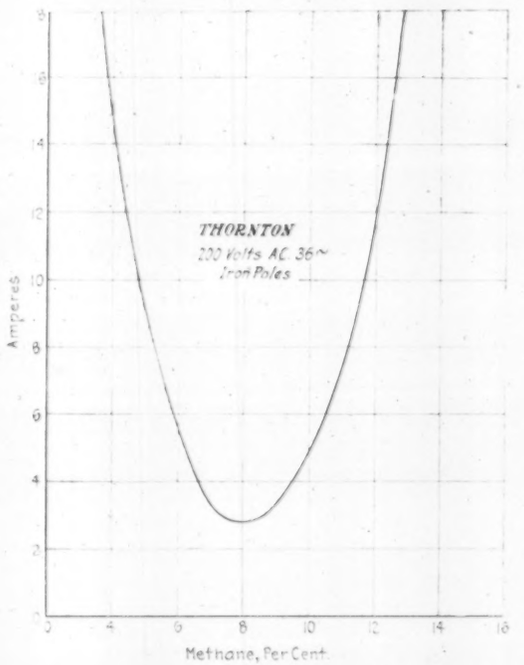


FIG. 9 (TOP) AND FIG. 10 (MIDDLE) VARIATION OF LEAST CONTINUOUS CURRENT REQUIRED TO PRODUCE A SINGLE IGNITING SPARK, WITH THE GAS MIXTURE; FIG. 11 (BOTTOM) SAME, WITH ALTERNATING CURRENT

W. M. Thornton found that a greater amount of energy is required to produce an igniting spark by an alternating current than by continuous current, and the relationship between the number of volts and amperes in the circuits immediately prior to the production of the spark differs in character in the two cases.

These and other experiments suggest ionization as the origin of ignition. Dr. H. F. Coward expresses the opinion that the ignition of an inflammable gas mixture is largely governed by two factors, namely, its thermal conductivity and the energy degraded when the discharge is passed.

In a general way it is known that gas mixtures are only combustible when the proportions lie within certain limits. Fig. 9, taken from R. V. Wheeler's Home Office Report on Battery-Bell Signalling Systems, shows how the least continuous current required to produce a single igniting spark varies with variations in the gas mixture.

From this it is seen that the most sensitive mixtures lie between 7.5 and 9 per cent of methane. The first value of this curve is to show the limits of inflammability and the general character of the current variation between these limits. This curve has been obtained on an alternating-current circuit, and Professor Thornton, who used a continuous current, obtained a curve of a different form, as shown in Fig. 10. It must be borne in mind, however, that the ordinates of these two curves are not comparable, since the least igniting current diminishes as the voltage or inductance increases.

In Fig. 10 a portion of the curve follows closely the straight line which passes very nearly through the origin. From this Professor Thornton argues that the igniting current is proportional to the number of molecules of combustible gas in unit volume of the mixture. With alternating current, Fig. 11, the character of the curve alters, the current varying as the "square of the excess of either of the combining gases on each side of the point of maximum inflammability."

The writer considers the validity of the method of determining the ability of the spark to ignite the gas, or the "incendivity" of the spark, by specifying the number of volts and amperes or the number of amperes and the inductance in the circuit prior to the formation of the spark.

With alternating current the amount of current for a given voltage is always higher than in the case of direct current, but all data show that the amounts of voltage and current or current and inductance capable of producing dangerous sparking are comparatively small. This emphasizes the necessity of adequately protecting electrical apparatus to which explosive gases are accessible, which in particular applies to the case of electric bells.

The author finds that a single spark which, when repeated slowly will not ignite the gas, will, after a more or less definite interval, produce ignition when repeated rapidly, which indicates that the element of time is a factor of importance in ignition phenomena. If, instead of a single-break device, a vibratory make-and-break device, such as the trembler of a bell, be employed, the ability of a spark to ignite a gas mixture is found to depend upon the duration of the spark as well as upon the circuit conditions.

A writer in the *Electrical Review* (vol. 77, p. 65, 1915), on the basis of the work of Professor Thornton and Dr. Wheeler, states that the igniting power of a break-flash depends on the $Li^{1.54}$ of the circuit, where L is the inductance and i the circuit current.

As regards the use of the product volts times amperes, vi, as in measure of the power of the arc, the author points out that the value of vi is not necessarily the same during arcing as

when the contacts are brought together, and there is no reason for assuming them to be the same when the arc is only of momentary duration. Therefore, *vi*, as it exists prior to sparking, is not a measure of the power of a hot-point spark.

The general conclusion to which the author has been led by his experiments is, that it is necessary to distinguish between the energy which produces a spark and that quality of the spark called by him "incendivity," which enables the spark to cause ignition, and that the magnitude of the one is not a measure of the other, although there may be a more or less regular relation between them when certain physical conditions are kept constant.

Ignition seems to depend on the ionization caused by the spark during the interval of sparking. The ionization may be rapidly dissipated or neutralized. If the neutralizing action predominates, there is no ignition of a gas mixture. If there is little or no neutralizing action, ignition occurs immediately. Between these two limits there are a variety of intermediate conditions which apparently account for the delay of ignition found in some of the experiments and much of the great irregularity that is often experienced in experimental work on the subject.

The rest of the paper refers to dangerous sparking of electrical apparatus for mining and of electric bell-signaling circuits. In this connection, the writer believes that the British Home Office Regulations, limiting the highest permissible voltage in bell-signaling systems to 25, does not secure safety, and the limit ought to be reduced to 6 volts. The fixing of the voltage limit in itself, however, is not sufficient to insure safety, and there should be added the condition that sparks produced in the system should not be capable of igniting a specified mixture of methane and air, which result can be easily obtained with a relay.

E. A. Watson, in a written discussion on the above paper, expressed his belief that the value of the minimum energy in the spark required to ignite a gas would be affected by the pressure, and still more certainly by the temperature, of the explosive mixture before ignition. The fact that, although one spark will not ignite a given mixture, yet a rapid succession of sparks will do so, might be due to the heating of the mixture by the energy liberated. The problem of how the horsepower given by an engine depends, other conditions remaining the same, upon the energy given by the magneto, is one which would well repay investigation. There are, however, no data available to show whether an increase in brake horsepower might be obtained by increasing the energy at the spark plug. (Some rough experiments made on a comparatively low-speed gas engine give a negative result, but these experiments were only very rough and cannot be considered as being at all conclusive, especially as the effect would be most marked at high engine speeds.) (*The Journal of the Institution of Electrical Engineers*, vol. 54, no. 254, p. 196, January 15, 1916, 13 pp., 11 figs., *et*)

INTERNAL-COMBUSTION TURBINE, A. W. H. Griepe

Description of the construction and operation of a 100-hp. internal-combustion turbine which, it is said, has made a number of runs with an efficiency estimated by a rough test at about 20 per cent.

The turbine consists of a rotor similar to that used in a reaction-type turbine, with the blades distributed in four equally spaced groups around the periphery of the wheel, each group occupying one-eighth of the circumference. On the rotor is mounted a valve band which acts as an admission and cut-off valve between the explosion chamber and the fuel and air supply. The stationary element contains the explosion chamber and ring chambers for the fuel and air supply. The nozzles are mounted so that the gases flow from the inner to the outer periphery of the wheel.

The operation of the turbine is as follows: Compressed air enters the air chamber from the storage tank at from 45 to 75 lb. and gas from the fuel chamber at approximately atmospheric pressure. The compressed air flows in through specially formed passages, and in doing so acts as an injector and draws the fuel in through a small, straight nozzle in the center of each valve. By means of a special arrangement in the valve ring, the port between the fuel and the explosion chamber is closed an instant before the port is opened from the explosion chamber to the blade, and at this instant the charge is ignited and expands.

The operation of the turbine may be seen from the cycle diagram in Fig. 12. Starting at I, explosion is complete and the ring valve is just beginning to open the air valve,

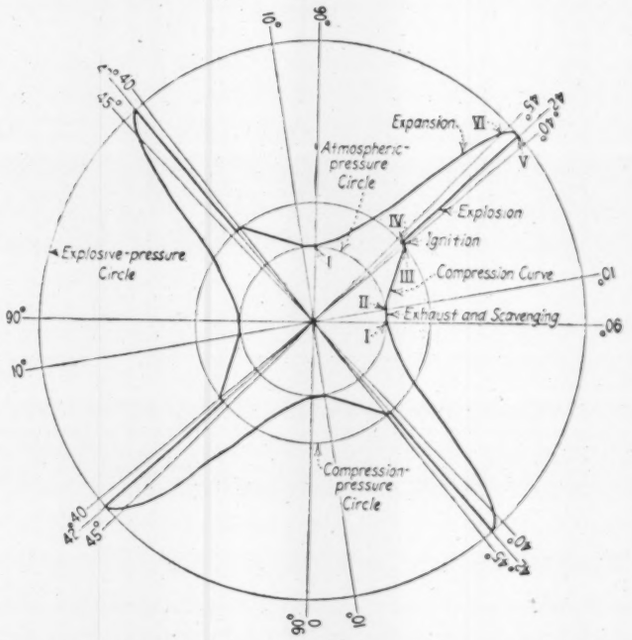


FIG. 12 CYCLE DIAGRAM OF AN INTERNAL-COMBUSTION TURBINE

with the explosion chamber still open to atmosphere. Air is admitted to the explosion chamber, blows out through the exhaust, and scavenges the explosion chamber. This continues for 10 deg. of the revolution, at which point the nozzle from the explosion chamber is closed by the inner rim of the rotor. At II, the valve band opens the fuel valve, admitting a fresh mixture into the explosion chamber, and the pressure rises, owing to the pressure of the compressed air. At III, 40 deg., the valve band closes the admission opening. When the valve band has overlapped one degree, at IV, 41 to 42 deg., ignition takes place. At this point the highest pressure, V, is obtained. From 42 to 45 deg. the nozzle is opening from the explosion chamber and expansion begins. From 45 deg., VI, to 90 deg. the nozzle is wide open and expansion takes place. At 90 deg. the cycle is complete and begins over again.

In the first installation a 3-in. by 4-in. Gardner compressor was used. The amount of air delivered was large enough for two explosion chambers, the air leakage between the tank and the explosion chamber being at that stage about 25 per cent.

Adjusting nozzles were then installed and reduced the losses to about 10 per cent. A 6-in. by 6-in. double-cylinder Curtis compressor was then installed with modified means to reduce the leakage. With the best arrangements thus far developed, the power necessary to compress the air was about 12 per cent of the whole power developed.

The combustion never gave any trouble.

The blades are made of cast iron and inserted in the rotor. The sections are cast in one piece.

No data of any tests are given, but from a statement made in another connection it appears that runs were made at speeds up to 3500 r.p.m. (*Power*, vol. 44, no. 23, p. 785, December 5, 1916, 3 pp., 14 figs., *d*)

Machine Parts

Friction Clutches, Wm. G. Gass

The writer divides all clutches into a number of distinct types, such as claw couplings, friction cones, internal-segment-and-band clutches, external-segment-and-band clutches, plate clutches, brush clutches, magnetic clutches, and automatic clutches, and discusses the distinctive features of each type separately.

As to friction materials, the author believes that while they are of advantage for brakes, there are difficulties in the way of using them for clutches. In most cases rivets have to be depended on, and these are apt to give way. The material is liable to glaze, particularly in a clutch thrown in and out many times. Where steel is employed it should not be used on cast iron unless its surface is chilled very hard. The trouble of driving surfaces is that they wear away, and this wearing is greater or less as the clutch slips or not. If there is slippage, the surface generally being dry, a small portion of matter gets embedded into whichever of the surfaces is softer and acts as a kind of plow into the other. It is not necessarily the softer of the two which gives way, but often the harder.

Clearance is the main difficulty with clutches, and the smallness of it is the cause of a considerable amount of wear when running out of gear. In all cases where the setting up is done by screws, the clearance between the driving part and the driven is relatively smaller. Attempts have been made to increase the clearance by racks to rotate the screw through a pinion, but this does not enable the necessary pressure to be put on the screw, and there is consequently a loss of efficiency. Generally speaking, clutches of all kinds wear away more quickly out of gear than when they are in gear, even where they are strong enough to easily cope with the load. Clearances are, therefore, a weak spot in almost all types of clutches, being so small that any wear which occurs in the bushes of the free part of the clutch affects its running.

Setting-up Gear. The action of setting up a clutch is the conversion of a sliding movement along the shaft carrying the clutch into a pressure between the clutch surfaces. This may be properly divided into two operations. The first, that which is in the clutch itself, and the other, that by which the power for operation is applied. The locking and concentration of power may be obtained either by a double joint or by a wedge, but in both cases a slight application is necessary to transmit the power from the stationary lever to the rotating shaft carrying the clutch. The power may be applied to the clutch either to set it in gear or to release it, i.e., to put it out of gear, the clutch being in this case kept in gear by means of springs.

The matter of *pressure on working faces* is a crucial point in the efficiency of any clutch and its power to drive. It is usually considered that if an actual pressure of 50 lb. per sq. in. can be put on the surfaces, it is as much as is desirable for good working conditions, but if for any reason a less pressure is put on than that required to transmit the power, the clutch will, if it begins to slip, grind itself away quickly and, in the spring-center type, grind away all the available spring in the metal. As to pins, in spite of all that can be done they will wear away, so that if a clutch is set up correctly a very small wear on the pins and links of the toggle will rapidly reduce the effective pressure of the faces.

The *power transmitted* is proportional to the speed of rotation, and the clutch which will transmit 10 hp. at 100 revolutions will transmit 50 hp. at 500 revolutions.

Lubrication in clutches is of the greatest importance, particularly where the clutch is running idle for a considerable part of its time. If the outside portion of the clutch is the driven part, it runs on the shaft and may have to be stationary while the shaft rotates in the clutch bushes, or, if the outside is the driver, it has to run loosely on stationary shaft. This is a source of trouble with many clutches, and the lubrication of these bushes requires the closest attention, both in design and on the part of the attendant.

In starting up any friction clutch a certain amount of rubbing takes place, and when two metal surfaces rub on one another, fine particles of metal are given off. In an enclosed chamber these cannot get away, become mixed with the lubricant, and form an excellent abrasive which does not increase the life of the part. This can be obviated by an occasional cleaning of the chamber, which, however, is not usually done.

Another peculiarity of lubrication in the case of plate clutches is that where the resistance to the idle clutch is not very great, if the oil becomes thick the plates adhere because all the air is driven out between them and the resistance may not be able to make the clutch stop. Springs between the plates have been tried to obviate this, but without great success. Excessive lubrication also reduces the driving power materially.

The speed at which the clutch is to run is an important point to consider, as well as the balance of the clutch. The clutch is rapidly affected by any want of balance if the speed reaches a point at which the want of balance becomes operative. The clutch should, however, be properly balanced for any speed. The cone having no moving parts is undoubtedly the easiest to balance and keep in balance; it has, however, certain inherent defects which stand in the way of its more extensive use. Another point which sometimes affects the use of the clutches is the overall space required.

The writer discusses further the field of application of clutches. In his opinion the *ideal friction clutch* should be a combination of a friction drive and a positive drive, i.e., a friction arrangement should be used for starting up and then a positive drive should come in operation and all driving be taken off the frictional portion. The clutch, however, should be able to be thrown out of gear with the same ease that the friction drive can give, and should have all the running parts with ample clearance when running out of gear. While this is not impossible, it is very difficult to attain, especially as the clutch should always be in perfect balance, with no projecting parts, properly lubricated, and free from complications. (Paper read before the Manchester Association of Engineers, October 28, 1916; abstract made from a reprint in the *Mechanical Engineer*, vol. 38, no. 980, p. 342, November 3, 1916, 4 pp. *dg*)

Mechanics

RECENT OBSERVATIONS ON THE CRITICAL SPEED OF SHAFTS, Prof. A. Stodola

In observing the critical angular velocity of smooth shafts, the writer has been surprised to find that the deflections at the critical speed were in nowise "infinite," but that the values always remained finite, even when the shaft was entirely free and without support at one end. This finite characteristic of values and deflection appears in a still more striking form in the interesting observations communicated to him by Brown, Boveri & Co. They submitted a photograph of a rotating shaft having a slight taper, this photograph being taken at the second critical speed of the shaft. If now the trough in which the shaft is located be filled with water, the shaft at the same speed takes an entirely different shape and the deflections, which even before were not very large, disappear practically entirely. This experiment shows that in the case of shafts immersed in a liquid, for example, propeller-screw shafts sticking out from the side of the vessel, the critical speed may be permitted without any danger of producing thereby excessive vibrations. It also indicates a possible explanation for the phenomenon referred to above, namely, that apparently the deflection of a shaft is affected by the viscosity of the medium surrounding it. One may assume that a certain amount of the fluid adheres to the shaft, revolves with it, and thereby reduces the critical velocity.

This question is entirely elucidated by the data published by Dr. O. Föppl, according to which, in the case of a heavy disk, the center of gravity of the disk, the point of "breakdown" of the shaft, and the point of intersection of the geometric axes through the center of the bearing will not rotate on a straight line as has been hitherto theoretically assumed. Such a deviation from the straight line can, however, occur only if the resisting forces are not negligibly small as compared with the centrifugal and shaft forces, which must be the case in the rotation of turbine disks either in free air or in steam. (*Neuere Beobachtungen über die kritischen Umlaufzahlen von Wellen*, Prof. Dr. A. Stodola, *Schweizerische Bauzeitung*, vol. 68, nos. 18, 19, pp. 197, 209, October 28, November 4, 1916, 5 pp., 10 figs. *etA*)

Steam Engineering

PRESSURE TESTS OF WELDED BOILER-TUBE VESSELS, Robert Cramer

Data of tests of simply welded joints tested under hydraulic pressure.

The samples were welded either by simple butt welding or in various improved ways. Among other things dished-in heads were welded on to seamless steel tubing. Some of the samples were annealed before testing, while in others the joint was welded in the same manner as the Winslow boiler tubes are welded into their headers.

The tests, in the opinion of the author, seem to show that acetylene welds of joints of the type tested can be made as strong as the tube itself. Sections of welds have been etched with a mixture of sulphuric and hydrochloric acid for about 6 hours, and the difference in appearance between the original tube and the added material was hardly discernible.

In the test with dished-in heads welded on to a seamless steel tubing, at a pressure of about 2500 lb. one dished head bulged out, the action having the appearance of the head being of rubber. This distortion strained the weld, which tore at 3000 lb. per sq. in. It is also interesting to note that in several cases a rupture occurred, not in the weld, but near it.

Similar tests were made with electrically welded joints, with the result that they appeared to be poorer than acetylene-welded joints under pressures exceeding 3000 lb. Many of the samples discharged sufficient water through a large number of very fine holes to prevent the pressure from being carried higher than 5000 lb. per sq. in. (*Power*, vol. 44, no. 23, p. 772, December 5, 1916, 3 pp., 10 figs., *e*)

STEAM MOTOR VEHICLES, Abner Doble

General discussion on steam-driven road vehicles such as automobiles, with a description of the Doble system.

One great disadvantage of the steam car has been the insufficient mileage that was obtained from the water that could be conveniently carried. The usual car did not carry condensing apparatus which would enable it to make continuous runs of much more than 100 miles without refilling. The honeycomb radiator was not used because it was feared that the thick oil was liable to clog the extremely small passages and that the exhaust steam was liable to melt the solder. It

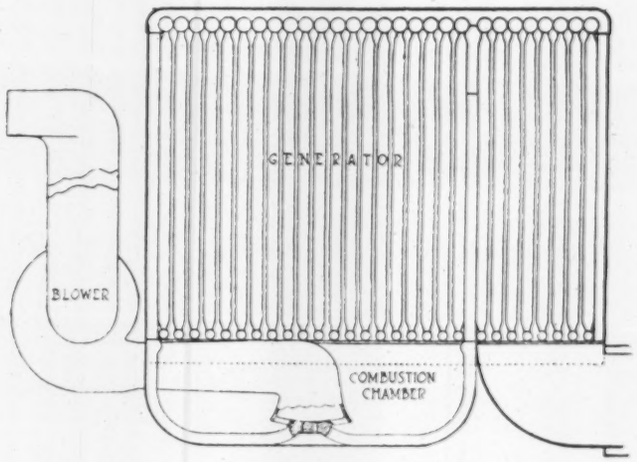


FIG. 13 DOBLE STEAM GENERATOR FOR MOTOR VEHICLES

was also believed that oil would injure the boiler by causing violent foaming, as the successful lubrication of the steam engine required a heavy oil. The writer states that he put a honeycomb radiator on a car and operated it with a fire-tube boiler in 1913. He found that the car would run anywhere from 1000 to 1500 miles at one time on 24 gal. of water, the boiler operation being entirely unaffected by the oil pumped into it from the engine cylinder.

The selection of the type of boiler was a serious problem. The steam generator, Fig. 13, is a flash generator in theory, yet has the appearance of a water-tube boiler and has a water level in the evaporating zone. The close and regular heating surfaces give heat-transfer conditions resembling those of a fire-tube boiler, but the water flow in counter-current to the flow of the gases and with no circulatory flow is characteristic of the flash type. The water enters at the bottom of an economizer zone and flows to the top under the action of the pumps and gravity, the hottest water collecting at the top. From there the water overflows through a connecting pipe into an evaporating zone, where it is converted into steam. The water level is maintained to half way up the generator by an automatic by-pass valve so arranged that when the regulator tube is filled with steam the by-pass valve is closed

by the expansion of the tube, forcing the water from the pumps to lift the check valve. The water can then enter the generator. As the water level rises, the regulator tube is filled with water from an exhaust pipe leading from the water manifold. This water is not in circulation in the generator and therefore remains quite cool. The regulator tube then contracts and opens the by-pass valve, allowing the water to return to the tank.

The generator tubes are vertically swaged at the ends to half their diameter and welded into horizontal headers top and bottom.

An important disadvantage of steam cars in the past has been the loss of time in getting the burner started to raise steam. The writer tried to use a carburetor and spark plug with the blower driven by an electric motor to furnish the requisite air. Means were also found to use kerosene for starting, without recourse to gasoline. For this purpose conditions were established under which kerosene could be ignited by an electric spark. Thus, in the complete apparatus there is an electric motor directly connected to a multivane blower and a graduated kerosene pump. This pump draws a measured quantity of fuel from the supply tank and forces it through the atomizing nozzle, the resultant fog being ignited by a spark plug. To stop the combustion it is only necessary to break the blower-motor circuit. The starting of the fire takes about 6 min. and requires the care of the operator until it is going well. After the fire is started, steam is made quickly. The engine used is a single-expansion uniflow engine with a cut-off at 5 per cent of the stroke. The engine directly geared to the axle with a 47 to 48 ratio can produce enough torque to slip the driving wheels on dry ground. (*S. A. E. Bulletin*, vol. 11, no. 2, p. 158, November 1916, 8 pp., 3 figs. *d*)

GAS-FIRING INSTALLATIONS FOR STEAM BOILERS, Pradel

Continuation of a serial article. The beginning of the article has not been abstracted, as the issues of the paper containing it have not yet been received by the Library, apparently because of the delays and uncertainties in the delivery of mails coming from Germany. It may also be stated in this connection that a number of technical periodicals have not been received because of the prohibition, by the German Government, of the export to the belligerent and neutral countries of certain technical and medical publications.

Among other things, the article describes safety devices used on the burners and piping in gas-fired boiler plants. Wherever gas firing is used, there is always the danger of the formation of an explosive mixture of gas and air. In particular, irregularities in gas pressure, such as excessive pressure or excessive velocity of the flow of gas, may tear away the flame and extinguish it for a short period. Then the continuation of the flow of gas into the firing chamber will gradually fill it with the mixture of gas and air, which may be subsequently ignited by contact with the hot walls and cause an explosion. Excessively low pressure in the gas piping may also lead to an explosion through the penetration by suction of air into the gas piping, and the consequent formation of an explosive mixture.

The Moll safety shut-off valve is proposed as a means to combat this danger. The Moll burner can be applied only where each firing chamber has one separate burner. Where a single firing chamber requires such a large amount of gas that several burners have to be installed, the Moll burners are arranged in such a manner that one burner, usually the middle one, acts as an igniting burner.

Such an arrangement is shown in section in Fig. 14. The main firing burner *a* has an auxiliary igniting burner *b* supplied with gas independently from the main burner installation, and so arranged that it can be operated independently of the same. The flow of gas from the main burner installation is automatically cut off until the igniting burner is cut in, and until it has, by the use of the reducing flame, entirely consumed the oxygen present in the air in the firing chamber. With this in view, the igniting burner is provided with a valve gear connected with the handwheel of the cut-off valve *d* regulating the gas admission to the main firing system. When the igniting burner is cut out, this mechanism grips the handwheel of the valve, and does not relieve it until the igniting burner has been cut in again.

Safety devices to protect against variations of pressure in the supply of gas and explosions produced thereby, are usually built into the gas piping proper. Essentially, they are regulators of pressure, limiting the pressure either outward or downward. In the first place, when the maximum pressure is exceeded, a by-pass is opened for the gas; in the second place, when the pressure reaches its lowest limit, the gas supply is entirely cut off. Salau & Birkholz, for example, use a device wherein the gas-admission cocks on the burners are provided with wires attached to a minimum pressure regulator. At a certain definite minimum pressure, the regulator releases a weight, the fall of which instantly closes the cocks on all the pipes leading to a given battery of boilers.

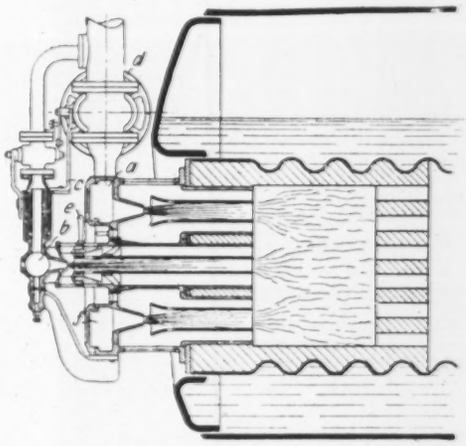


FIG. 14 MOLL BURNER WITH PILOT AND MAIN FIRES

In safety installations of this kind it is essential that the opening of the by-pass or the closing of a gas valve by the pressure regulator be of such a nature that the reverse action should not take place when the pressure reaches its normal level. The device should be so arranged that it can be reopened only by hand. This is so provided in the safety cut-off valve of the Westfalische Maschinenbau-Industrie Gustav Moll & Co., A-G., in Neubeckum, shown in vertical section in Fig. 15. The pressure governor consists of a bell *a* immersed in a cup on the gas piping *b* filled with an inert liquid, the device being so arranged that the immersion takes place when the supply of gas falls below a certain limit. When the bell reaches its lowermost position, the pendulum *c*, suspended from the cover of the valve, moves downwards until it reaches a small groove in the bell, and thereby prevents it from rising again. The pressure of the gas then begins to act on the

liquid, then at level d, and raises it to the position indicated by e, corresponding to the highest permissible gas pressure, in such a manner that no further flow of gas can occur. The rise of the level of the liquid in the gage glass indicates to the fireman that full gas pressure is again available. In order to admit gas again to the burners, the pendulum holding the bell must be released by pulling on the handle f, or pressing down the lever g, whereupon the bell will be raised by the gas pressure far enough to permit the flow of gas through the orifices h.

The valve can be so devised that the bell may be held in place during the course of operation, that is, even when the pressure is below normal.

The article also describes the safety cut-off valve built by P. Hoss in Langenbockum, shown in section in Fig. 16. The chamber a is built in onto the gas pipes l and g, the pipes entering into the chamber by means of elbows b and b_1. Over the chamber a is located a water-filled chamber i, with a valve p on the bottom, this valve closing the short pipe k leading to the chamber a. The valve p is operated by the lever rod f,

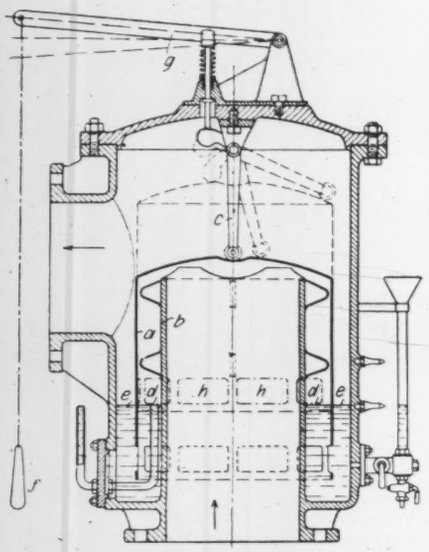


FIG. 15 MOLL AUTOMATIC SAFETY CUT-OFF VALVE

of which the dead weight may be equalized by the adjustable weight m in such a manner that the flow of gas is prevented from opening the valve p, which in this case is no longer supported by the flap v. In the chamber a are likewise located the floats, c and c_1, running in guide cages e and e_1, these floats being arranged in such a manner that when the water level in chamber a rises they press against the openings of the elbows b and b_1. With the lever system f is connected an electric contact, in such a manner that it announces, by the ringing of the bell, the closing of the valve. The amount of water is so proportioned that the openings in the elbows b and b_1 are just covered over, but no water can penetrate into the gas piping proper. In order to start the flow of gas after some trouble has occurred, all that is necessary is to let off some water from chamber a by the cock n, and to fill anew the water chamber i, which is usually provided with a water gage and peep glass.

(*Gasfeuerungen für Dampfkessel*, Pradel, *Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 39, no. 40, p. 315, October 6, 1916, serial article, not finished, *d*)

Varia

THE ENGINEERING SOCIETY, ITS PAST, PRESENT AND FUTURE ACTIVITIES, Ernest McCullough

Discussion of the objects and policies of engineering societies, with special reference to the conditions in Chicago.

The writer claims that while the engineer has become a technical man with a vocation recognized alongside the older professions of law, medicine and theology, the technical and engineering societies have not kept pace with this development. They still consider themselves as institutions organized solely for educational purposes, and the society proceedings have become encyclopedias which are consulted less frequently than are the pages of the journals maintained purely for profit.

The writer believes that the young man in the engineering society feels that he has not been paid the proper attention, and that "Engineering societies have for many years past been mutual admiration societies of successful men." The discussions at the meetings are too frequently inadequate, and real criticism is seldom developed when the author of a paper is of a commanding eminence. The young man learns some-

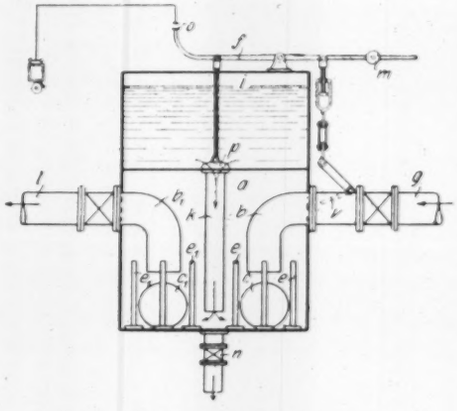


FIG. 16 HOSS SAFETY CUT-OFF VALVE

thing from the papers, but he feels diffident about discussing them, as he fears that his opinion would not be well received. "Get a reputation first," is the attitude of too many authors when they write a closure to a discussion.

The young man does not want this. He wants fellowship, companionship, and definite recognition. He is glad to attend a meeting where he knows refreshments will be served, not because of the refreshments, but because something to eat and drink signifies a lack of formality and perhaps an opportunity to mingle freely with men who have made their mark. He wants to feel that the society is more than an editorial body or an encyclopedic compilation of engineering facts.

The writer states that the young man is the central idea of the present policy of the Western Society, beginning with the new constitution of 1911, which provided for a grade known as student members.

The writer proceeds to discuss technical societies organized in Chicago by the younger generation of engineers, such as The Associated Technical Men and The American Association of Engineers, and in discussing their programs touches upon the activities of the Western Society of Engineers in connection with legislation—in particular, the licensing of engineers in the State of Illinois. As the author states, engineers were opposed to legislation to license engineers, but conditions in

the State of Illinois became so intolerable on account of the monopoly given to architects that The Western Society of Engineers obtained last year the passage of a law to license structural engineers. Further effort is being made to secure a lien law for engineers.

As regards publicity, the writer believes that the societies heretofore have concerned themselves with the publicity work of individuals. What is now a crying need is publicity work of a proper sort by the societies for the benefit of the membership, and incidentally of the technically educated men not members of any society.

It is the duty of engineering societies to break away from precedent and get back to first principles. They must become again the places where the interests of the young men are the concern of the older men. (*Journal of the Western Society of Engineers*, vol. 21, no. 8, p. 697, Oct. 1916, 12 pp. *g*)

Some Essential Features of High-Speed Engines, A. F. Milbrath

Discussion of the design of high-speed engines.

Such engines are built primarily for racing, where maximum output is the main consideration. To adapt them for stock cars certain modifications would be required to insure durability as well as to reduce the cost of manufacture. All of these modifications tend to reduce speed and mean effective pressure, so that the output is smaller as compared with that of the racing engine. The result is a compromise between high output on the one hand and durability on the other. The data presented in this paper are the result of several years' experimental work. Only the most important features are here abstracted.

In a high-speed engine a small diameter of cylinder with the long stroke is favorable, since the weight of the piston increases with some power of the diameter between the second and third, while the inertia forces on the piston vary likewise as long as the piston speed is constant. On the other hand, however, the weight of the engine will increase with the longer stroke, while the valve area will decrease with the smaller bore unless large valve pockets are used. The heat lost to the jacket water will be the less the smaller the area exposed to the gases in the cylinder. A shorter stroke has therefore its advantages. In Europe, stroke-bore ratios as high as 2 have been used successfully. From the author's experience ratios of 1.70 or 1.75 have given good results in 300-cu.-in. engines.

The volume of compression space should be about 18 to 20 per cent of the total volume, which will give compression pressures of about 90 to 110 lb. per sq. in. gage.

As to ignition, the author prefers two-point ignition with spark plugs on opposite sides, as, in his opinion, this gives more rapid combustion, more power, and reduced fuel consumption. As to valve springs, in actual practice at engine speeds of 3000 r.p.m. spring tensions of 80 lb. with valve seated have been satisfactory on 1¾-in. valves weighing, with accompanying reciprocating parts, 0.9 lb. For higher speeds greater spring tensions are necessary, which, however, involves difficulties in securing springs that will stand up for any length of time.

As to pistons for high-speed engines, the most important consideration is light weight. Aluminum-alloy pistons have the advantage of ease of manufacture, light weight, heat conductivity, and ample strength. Wristpin bearings can be formed directly in the aluminum. Thicker rings should be used, however, as thin rings are apt to wear into the aluminum, and this causes a gradual widening of the grooves.

Connecting rods should be light, but great strength is also necessary. Connecting rods, pistons and all the reciprocating parts must be balanced perfectly to insure freedom from vibration.

The writer discusses in detail the matter of crankshafts. He believes that with the shaft of liberal dimensions, sufficient mass is secured to absorb any vibrations set up by the light pistons and rods. No further balance weights are necessary, especially if the ratio of connecting-rod length to stroke is 2 or slightly greater. (*S. A. E. Bulletin*, vol. 11, no. 2, p. 115, November 1916, 8 pp., 1 fig. *g*)

Specification and Tests of the Transparency of Paper and Tracing Cloth

The Bureau of Standards, Department of Commerce, has just published a Circular under the above title (Circular No. 63). It describes a method of quantitatively specifying transparency for practical purposes, states the form of the specification and gives a description of the apparatus used to make measurements.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

A gasoline-driven two-furrow plow used in England weighs about 2300 lb. and develops about 11 h.p., requiring about 2 gal. of gasoline per acre plowed.

According to *The Engineer* (London), silver alloyed with 2 per cent of palladium forms a good substitute for platinum in contact-point and spark devices. The alloy which gives the greatest resistance to spark erosion is 60 per cent palladium and 40 per cent silver. Palladium raises the melting point and lowers the thermal conductivity.

In an interesting publication entitled "Personal Reminiscences of James Mapes Dodge," Charles Piez, Mem.Am.Soc. M.E., tells of the struggles, early failures and final great successes of one of the most commanding figures in American invention and engineering, and shows the genial, charming personality of Past-President Dodge, who did much to shape our present-day industrial ideals.

Professor W. F. Durand, on behalf of the National Advisory Committee for Aeronautics, is planning during the coming year to install at Leland Stanford Junior University, California, an aerodynamic laboratory for experimental investigation of problems in which the committee is concerned, and with special reference to the investigation of aerial propellers. He will undertake during the coming year in this laboratory an experimental investigation of such propellers, covering some fifty different forms of models, and with a view to the establishment of reliable design constants and characteristics for the use of naval and military designers and as a general aid to commercial designers in the development of this feature of the aeroplane.

SELECTED TITLES OF ENGINEERING ARTICLES

AIR MACHINERY

AIR DELIVERY FACTORS OF BLOWING ENGINES, W. Trinks. The Blast Furnace and Steel Plant, December 1916, 3 pp., 3 figs.

HIGH-PRESSURE AIR-COMPRESSORS, Joseph M. Ford. Engineering, vol. 102, no. 2653, November 3, 1916, 2 1/6 pp., 7 figs.

AUTOMOBILES

THE NECESSITY FOR LIMITING THE LOAD, SPEED AND SIZE OF VEHICLES, Eugene W. Stern. Motor Travel, vol. 8, no. 6, November 1916, 4 pp., illustrated.

† MANY FACTORS IN BRAKE DESIGN, John Younger. The Automobile, vol. 35, no. 22, November 30, 1916, 3 pp.
Tire adhesion, road and wind resistance and the personal equation—brakes on two wheels are enough.

† METHODS OF COMPARING AUTOMOBILE PERFORMANCE, Walter T. Fishleigh. S. A. E. Bulletin, vol. 11, no. 2, November 1916, 23 pp., 5 figs.

PLANT AT THE MARTINO'S TREATING AND TESTING WORKS, LTD. The Automobile Engineer, vol. 6, no. 96, November 1916, 3 pp., 7 figs.

THE DETERMINATION OF HEADLIGHT GLARE. The Automobile, vol. 35, no. 21, November 23, 1916, 3 pp.

CONVENTIONS

SAFETY ENGINEERS HOLD HUGE MEETING. The Iron Trade Review, October 26, 1916, 5 pp.
Fifth annual congress of the National Safety Council convened in Detroit at a record-breaking gathering; many lines of industry represented; iron and steel sessions are of unusual interest.

RAILWAY ELECTRICAL ENGINEER'S CONVENTION. Railway Electrical Engineer, vol. 7, no. 18, 9 pp., illustrated.

INDUSTRIAL ACCIDENT PREVENTION CONFERENCE. Monthly Bulletin, Pennsylvania Department of Labor and Industry, vol. 3, no. 5, May 1916.

NAVAL ARCHITECTS' ANNUAL MEETING. International Marine Engineering, vol. 21, December 1916, 10 pp.

NATIONAL FOUNDERS' ASSOCIATION MEETING. The Iron Age, vol. 98, no. 21, November 23, 1916. 1 p.

A NEW NATIONAL INDUSTRIAL ORGANIZATION. The Iron Age, vol. 98, no. 20, November 16, 1916, 3 pp.

ENGINEERING MATERIALS

† THE COMBUSTION AND FIREPROOFING OF WOOD: SOME MINUTE REACTIONS, James Scott. The Railway Engineer, vol. 37, no. 442, November 1916, 2 pp., 3 figs.

SULPHUR EFFECTS ON LOW CARBON STEELS, Carle R. Hayward. Steel and Iron, November 1916, 3 pp., 1 fig.

† THE TENSILE STRENGTH OF ASBESTOS ROPE WHEN EXPOSED TO FIRE. Engineering, vol. 102, no. 2654, November 10, 1916, 1 p.

THEORY AND PRACTICE OF ALLOYS WITH LOW FUSING POINTS. The Metal Industry, vol. 9, no. 10, Setpember 8, 1916, 2 pp.

† MODERN IDEAS IN HEAT TREATMENT. The Iron Trade Review, November 23, 1916, 3 pp., 4 figs.

RECRYSTALLIZATION AFTER DEFORMATION. The Iron Trade Review, November 23, 1916, 3 pp., 2 figs.

HEAT TREATMENT OF BRASS IN NEUTRAL AND REDUCING ATMOSPHERES, Alfred H. White and Bert A. Standerline. The Metal Industry, vol. 9, no. 19, November 10, 1916, 2½ pp.

CUPRO-VANADIUM: ITS VALUE IN VANADIUM BRONZES, James Scott. The Metal Industry, vol. 9, no. 19, November 10, 1916, 1¾ pp., 3 figs.

SPECIAL AIRCRAFT STEELS, I, DEFECTS. The Practical Engineer, vol. 54, no. 1551, November 16, 1916, 3¾ pp.

HEAT-TREATMENT OF AUTOMOBILE STEELS, Robert R. Abbott. S. A. E. Bulletin, vol. 11, no. 1, October 1916, 12 pp., 11 figs.

ALUMINUM IN MODERN AUTOMOBILE AND AVIATION CONSTRUCTION, James E. Diamond. S. A. E. Bulletin, vol. 11, no. 1, October 1916, 16 pp., illustrated.

HEAT-TREATMENT OF STEEL, Martin Syte. Machinery, vol. 23, no. 4, December 1916, 6 pp., 13 figs.

PREVENTING THE CORROSION OF PIPE, F. N. Speller. The Iron Trade Review, vol. 59, no. 22, November 30, 1916, 4 pp., 3 figs.

AIR FURNACE IRON FOR CAST IRON WHEELS, Charles V. Slocum. The Foundry, vol. 44, no. 12, whole no. 292, December 1916, 4 pp.

CARBONIZATION OF WROUGHT IRON IN GASES, F. W. Harbord. The Blast Furnace and Steel Plant, December 1916, 2 pp., illustrated.

EFFECT OF SULPHUR AND PHOSPHORUS ON STEEL. The Iron Age, vol. 98, no. 23, December 7, 1916, 3 pp.

PROPERTIES AND DEFECTS OF STEEL INGOTS. The Iron Age, vol. 98, no. 23, December 7, 1916, 2 pp.

PRÜFUNG VON GUMMI UND CHROMLEDER AUF VERWENDBARKEIT ALS FÜGENDICHTUNG BEI SCHLEUSEN, Von B. Stock. Mitteilungen aus dem Königlichen Material prufungsamt, vol. 32, January 1914, 11 pp., 5 figs.
Tests of rubber and chrome-leather for use in cup packing.

FOUNDRY

MOULDING AND CASTING CYLINDER LINERS, F. Andrew. Mechanical World, vol. 9, no. 1559, November 17, 1916, 1 p., 10 figs.

USE OF BORINGS IN CUPOLA OPERATIONS. The Foundry Trade Journal, and Pattern Maker, vol. 18, no. 179, November 1916, 2 pp.

FUELS AND FIRING

ALCOHOL—THE FUEL OF THE FUTURE, Bernard N. Glick, M.Sc. The Automobile, vol 35, no. 22, November 30, 1916, 3 pp., illustrated.

A PNEUMATIC SYSTEM FOR BURNING POWDERED COAL. Compressed Air Magazine, vol. 21, no. 11, November 1916, 1 p., 1 fig.

THE COST OF COAL, Geo. Otis Smith and C. E. Lesher. Science, vol. 44, no. 1144, December 1916, 10 pp.

THE COST OF COAL, Geo. Otis Smith and C. E. Lesher, United States Geological Survey, November 14, 1916, 13 pp.

THE ECONOMIC AND SCIENTIFIC TREATMENT OF COAL, Sydney H. North. Cassier's Engineering Monthly, vol. 1, no. 5, November 1916, 4½ pp.

MODERN PRACTICE IN FUEL BRIQUETTING, W. P. Frey. Coal Age, vol. 10, no. 24, December 9, 1916, 4 pp., 6 figs.

FEUERUNGSANLAGEN MIT KÜNSTLICHEM ZUG. Schweizerische Bauzeitung, vol. 68, no. 15, October 7, 1916, 2 pp., 2 figs.
Firing installations with mechanical draft.

FURNACES

ELECTRIC OVENS IN AN AUTOMOBILE PLANT. The Iron Age, vol. 98, no. 22, November 30, 1916, 5 pp., illustrated.

HEATING AND VENTILATION

BETRACHTUNGEN ÜBER MECHANISCHE LÜFTUNG, Konrad Meier. Schweizerische Bauzeitung, vol. 68, no. 20, November 1916, 5 pp.
Mechanical ventilation.

THE FREQUENT BURSTING OF HOT WATER PIPES IN HOUSEHOLD PLUMBING SYSTEMS, F. C. Brown. Physical Review, vol. 8, no. 5, second series, 4 pp.

NEWLY COLLECTED DATA ON HEATING AND VENTILATION, Edward B. Johnson. The Heating and Ventilating Magazine, vol. 13, no. 11, November 1916, 6 pp., 4 figs.
Heat losses through building materials, B.t.u. required for heating air, rules for computing radiation, recessed radiators, enameling radiators.

CENTRAL HEATING AND POWER PLANT, University of Toronto, L. M. Arkley. The Power House, vol. 9, no. 11, November 1916, 6½ pp., 14 figs.

HYDRAULICS

MACCHINE IDRAULICHE, Prof. Ing. J. Dejust. L'Industria, vol. 30, no. 44, October 29, 1916, 3 pp., 2 figs.
Hydraulic machines.

LARGE MODERN LOCK GATES, Malcolm Elliott. Journal of the Western Society of Engineers, vol. 21, no. 8, October 1916, 37 pp., 7 figs., plates.

MEETING INCREASED LOAD DEMANDS. Practical Engineer, vol. 20, no. 22, November 15, 1916, 6 pp., 7 figs.
Large hydraulic elevator and modern air conditioning and sewage disposal apparatus added to power plant equipment of Boston Store, Chicago.

SUR LA TRANSMISSION DES COUPS DE BÉLIER DANS LES CONDUITES PRÉSENTANT DES BIFURCATIONS. APPLICATION AUX CHEMINÉES D'ÉQUILIBRE, M. Dennis Eydoux. Comptes Rendus Hesdomadaires des Séances de L'Académie des Sciences, vol. 163, no. 15, October 9, 1916, 5 pp.
Transmission of water-hammer in forked conduits.

APUNTES PARA UNA TEORIA RACIONAL DEL COEFICIENTE DE CONTRACCION HIDRAULICA. La Inginieria, vol. 20, no. 7, October 1, 1916, 17 pp., 8 figs.
Concerning a rational theory of the coefficient of hydraulic contraction.

IGNITION

PHILBRIN BATTERY IGNITION SYSTEM. The Horseless Age, November 15, 1916, 2 pp., 5 figs.

SPARK PLUGS, Lieut.-Com. J. O. Fisher, U. S. N. Journal of the American Society of Naval Engineers, vol. 28, no. 4, November 1916, 6 pp.

† Abstracted in the Engineering Survey in this issue.

INTERNAL-COMBUSTION ENGINEERING

SKANDIA ENGINES MADE IN SAN FRANCISCO. Motorship, vol. 1, no. 6, October, 1916, 2 pp., illustrated.

350 B. H. P. CROSSHEAD TYPE DIESEL ENGINE. The Engineer, vol. 122, no. 3176, November 10, 1916, 3 pp., 9 figs.

NEW THOMAS 135 H. P. AEROMOTOR, Raymond Ware, vol. 31, no. 2, November, 1916, 3 pp., 4 figs.

"KNOCKING" IN INTERNAL COMBUSTION ENGINES. The Practical Engineer, vol. 54, no. 1551, November 16, 1916, 1 p., 3 figs.

CONSTANT PRESSURE CYCLE TRULY EFFICIENT, Arthur B. Browne and Herbert Chase, The Automobile, vol. 35, no. 22, November 30, 1916, 2 pp., 1 fig.

AUTOMOBILE-ENGINE CYCLES OF THE FUTURE, Herbert Chase. S. A. E. Bulletin, vol. 11, no. 2, November, 1916, 21 pp., 3 figs.

LUBRICATION OF SLIDE VALVES FOR SUPERHEATER. Cassier's Engineering Monthly, vol. 50, no. 3, September, 1916, 3 pp.

TESTS WITH GASOLENE-KEROSENE MIXTURES. The Gas Engine, vol. 18, no. 12, December, 1916, 1 p.

FOUR-CYLINDER DOUBLE ACTING GAS ENGINE. The Engineer, vol. 122, no. 3177, November 17, 1916, 1 p., 4 figs.

†SOME ESSENTIAL FEATURES OF HIGH SPEED ENGINES. A. F. Milbrath. S. A. E. Bulletin, vol. 11, no. 2, November, 1916, 8 pp., 1 fig.

TRIALS OF A DIESEL ENGINE, AND APPLICATION OF ENERGY-DIAGRAM TO OBTAIN HEAT BALANCE, F. Trevor Wilkins. The Journal of the Institution of Mechanical Engineers, no. 8, November, 1916, 25 pp., 10 figs.

A UNIQUE AMERICAN OIL ENGINE, Frank C. Perkins. The Isolated Plant, vol. 8, no. 12, December, 1916, 3 pp., illustrated.

THE KNOX 300-H.P. AERO ENGINE, G. Douglas Wardrop. Aerial Age, vol. 4, no. 10, November 20, 1916, 2 pp., illustrated.

KNOX AVIATION TWELVE TESTED. The Automobile, vol. 35, no. 20, 5 pp., illustrated.

†TRUCK AND TRACTOR ENGINES, H. L. Horning. S. A. E. Bulletin, vol. 11, no. 1, October, 1916, 19 pp., 3 figs.

MACHINE SHOP

GALT MACHINE SCREW COMPANY—ITS PLANT EQUIPMENT AND PRODUCT. Canadian Machinery and Manufacturing News, vol. 26, no. 18, November 2, 1916, 5 pp., illustrated.

MESTA DEVELOPS NEW GEAR PLANER. The Iron Trade Review, October 26, 1916, 1 p., 2 figs.
Pittsburgh company designs new machine for cutting herringbone gears and pinions. The gear blank is held rigid while tool goes through three different motions to properly cut tooth.

PRINCIPLES AND APPARATUS EMPLOYED IN TESTING LIMIT GAUGES, R. T. Glazebrook. Canadian Machinery and Manufacturing News, vol. 16, no. 20, November 16, 1916, 4 pp., 4 figs.

CONTROL MECHANISM OF BORING AND TURNING MILLS. The Mechanical Engineer, vol. 38, no. 982, November 17, 1916, ½ p., 1 fig.

BOILER REPAIRS MADE BY OXY-ACETYLENE AND ELECTRIC WELDING PROCESS AT WAYCROSS SHOPS, D. M. Pearsall. Southern and Southwestern Railway Club, vol. 13, no. 11, September, 1916.

TOOLS USED IN THE MACHINING OF MOTOR PARTS, Robert Mawson. American Machinist, vol. 45, no. 23, December 7, 1916, 3 pp., 11 figs.

UNUSUAL FLUE WORK AND TOOLS IN A RAILROAD SHOP. American Machinist, vol. 45, no. 23, December 7, 1916, 2 pp., 5 figs.

SCREW MACHINE EQUIPMENT, Oskar Kylin. The Iron Age, vol. 98, no. 22, November 30, 1916, 2 pp., illustrated.

JIGS USED IN THE MACHINING OF MOTOR PARTS, Robert Mawson. American Machinist vol. 45, no. 22, November 30, 1916, 2 pp., illustrated.

DOUBLE-HELICAL GEAR CUTTER. American Machinist, vol. 45, no. 22, November 30, 1916, 3 pp., 4 figs.

THE MANUFACTURE OF PUNCHINGS, C. W. Starker. American Machinist, vol. 45, no. 21, November 23, 1916, 6 pp., 7 figs.

PLANTS OF REMINGTON ARMS COMPANY, Hugh M. Wharton. American Machinist, vol. 45, nos. 21 and 22, November 23 and 30, 1916, 11 pp., 18 figs.

PROFILE AND INDICATING GAGES, Douglas T. Hamilton. Machinery, vol. 23, nos. 3 and 4, November and December, 1916, 27 pp., 108 figs.

ACIERS À OUTILS—TRAVAUX DE CHARIOTAGE ET DE FRAISAGE, P. Denis. Revue de Métallurgie, vol. 13, no. 3, May, June 1916, 3 pp.
Tool steels in cutting and milling.

MECHANICAL DIE-SINKING, Edward K. Hammond. Machinery, vol. 23, no. 3, November, 1916, 6 pp., 14 figs.

CHANGE-GEAR TABLES FOR SCREW CUTTING, Martin H. Hall. Machinery, vol. 23, no. 3, November, 1916, 1 p.

SPIRAL TYPE BEVEL GEARS, Reginald Trautschold. Machinery, vol. 23, no. 3, November, 1916, 7 pp., 12 figs.

LES ROUS DENTÉES À RESSORTS DES LOCOMOTIVE ELECTRIQUES DU LÖTSCHBERG, TYPE 1-E-1, Prof. Dr. W. Kummer. Bulletin Technique de la Suisse Romande, vol. 42, no. 19, October 10, 1916, 3 pp., 1 fig.
Elastic gear wheels of the Loetschberg electric locomotives.

TAPER THREADING—1. Machinery, vol. 9, no. 215, November 9, 1910, 7 pp., 14 figs.

MEASURING APPARATUS

PROTECTION OF TRACK SCALE PARTS FROM CORROSION. Scale Journal, vol. 3, no. 2, November 10, 1916, 2 pp.

LIQUID MEASURING PUMPS, F. J. Schlink. Technologic Papers of the Bureau of Standards, no. 81, October 27, 1916, 27 pp., 27 figs.

MEASURING THE VISCOSITY OF OIL, H. C. Hayes and G. W. Lewis. The Iron Trade Review, October 26, 1916, 2 pp., 5 figs.
Several existing types of viscosimeters are discussed, the authors believing that most of these are subject to error. A meter based upon a new principle is described.

A LENGTH COMPARATOR FOR DETERMINING LINEAR COEFFICIENTS OF EXPANSION, Wm. L. DeBaufre. Journal of the American Society of Naval Engineers, vol. 28, no. 4, November 1916, 14 pp., 8 figs.

MECHANICS

L'APPLICATION DU PRINCIPE DE SIMILITUDE EN MÉCANIQUE. Bulletin Technique de la Suisse Romande, vol. 42, no. 19, October 10, 1916, 2 pp., plates.
The application of the principle of similitude in mechanics.

BEREGNING AV MASTEFUNDAMENTER. Teknisk Ukeblad, vol. 63, nos 42 and 43, October 20 and 27, 1916, 4 pp.
Calculation of foundations for masts.

†FRICTION CLUTCHES, W. G. Gass. Mechanical World, vol. 60, no. 1558, November 10, 1916, 2 pp.

†NEUERE BEOBACHTUNGEN ÜBER DEI KRITISCHEN UMLAUFZAHLEN VON WELLEN. Schweizerische Bauzeitung, vol. 68, no. 18, October 28, 1916, 3 pp., 9 figs.
Modern observations on the critical speeds of shafts.

THE TORSION OF SOLID AND HOLLOW PRISMS AND CYLINDERS, Cyril Batho. Engineering, vol. 102, no. 2656, 2 pp., 2 figs.

STRESSES IN IMPACT, Armin Elmendorf. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 20 pp., 9 figs.

SPRINGS, C. E. Squire. The Mechanical Engineer, vol. 38, no. 984, 3 pp., 2 figs.

DE EVENWICHTSVOORWAARDE BIJ SPANNINGS BEREKENINGEN, F. A. Vening Meinsz. De Ingenieur, no. 45, November 4, 1916, 4 pp.

SLAB DEFLECTION AND SUBSIDENCE OF COLUMN SUPPORTS IN A FLOOR TEST OF INTERNATIONAL HALL, CHICAGO, MADE SEPTEMBER 1913, Henry T. Eddy. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 10 pp., 2 figs.

DESIGN OF SYMMETRICAL HINGELESS CONCRETE ARCHES, Victor H. Cochrane. Proceedings of The Engineers' Society of Western Pennsylvania, vol. 32, no. 8, November, 1916, 68 pp., 22 figs.

MUNITIONS

MANUFACTURING PARTS OF TYPE 80 TIME FUSES, Donald Baker. Machinery, vol. 23, no. 4, December, 1916, 6 pp., 23 figs.

WHAT IS THE MATTER WITH THE MUNITIONS MAKERS? Fred H. Rogart. Machinery, vol. 23, no. 4, December, 1916, 4 pp.

EROSION OF GUNS—THE HARDENING OF THE SURFACE, Henry Fay. Bulletin of the American Institute of Mining Engineers, no. 120, December, 1916, 15 pp., 14 figs.

SPECIAL LATHES FOR 8-IN SHELLS, H. V. Haight. American Machinist, vol. 45, no. 23, December 7, 1916, 3 pp., 11 figs.

UNITED STATES MUNITIONS. American Machinist, vol. 45, nos. 20, 21, 22, and 23, November 16, 23, 30 and December 7, 1916, 39 pp., illustrated.

POWER GENERATION

HARNESSING A VOLCANO TO A 15,000-HORSE-POWER ELECTRIC POWER HOUSE, Professor Luiggi. Engineering, vol. 102, no. 2655, 2 pp.

PUMPS

THE CONDENSATION PUMP: AN IMPROVED FORM OF HIGH VACUUM PUMP, Irving Langmuir. General Electric Review, vol. 19, no. 12, December, 1916, 12 pp., 8 figs.

THE CONDENSATION PUMP: AN IMPROVED FORM OF HIGH VACUUM PUMP, Irving Langmuir. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 26 pp., 8 figs.

RAILROAD ENGINEERING

DIE LOKOMOTIVEN DER FURKABAHN. Schweizerische Bauzeitung, vol. 68, no. 16, October 14, 1916, 1 p., 1 fig.
Locomotives of the Turka Railroad.

INTAKES AND INTAKE LINES IN RAILWAY WATER SERVICE. Railway Review, vol. 59, no. 21, November 18, 1916, 5 pp., 10 figs.

PULVERIZED FUEL APPLICATION TO STEAM LOCOMOTIVES, Joel S. Coffin, Jr. Canadian Machinery, vol. 16, no. 21, November 1, 2, 3, 1916, 4 pp., 2 figs.

CAR WEIGHT REDUCED BY STEEL CONSTRUCTION. Electric Railway Journal, vol. 48, no. 21, November 18, 1916, 3 pp., 3 figs.
A description of the new steel interurban passenger car recently received by the Northern Ohio Traction and Light Company, Akron, Ohio. These cars combine reasonable weight with substantial construction and weigh 12,000 lbs. less than steel-underframe cars of the same type.

LARGE MIKADO LOCOMOTIVE MOUNTED FOR FUEL TESTS. The Railroad Herald, vol. 20, no. 12, November, 1916, 5/6 p., illustrated.

RAIL CORRUGATION STUDIED IN CHICAGO. Electrical Railway Journal, vol. 48, no. 20, November 11, 1916, 4½ pp., 8 figs.
Investigation of 72 miles of single track reveals corrugations to be as prevalent on ballast foundations as on concrete. Study also leads to the conclusion that curved head rails would greatly reduce the rate and amount of corrugation.

THE KIESEL TRAIN RESISTANCE FORMULAS, A. J. Wood. Railway Mechanical Engineer, vol. 90, no. 12, December, 1916, 2 pp., illustrated.

MODERN BRITISH GOODS LOCOMOTIVES, E. C. Poultney. Railway Mechanical Engineer, vol. 90, no. 12, December, 1916, 7 pp., illustrated.

REFRIGERATION

REFRIGERATION OF PERISHABLE FREIGHT IN TRANSIT, M. E. Pennington. Railway Age Gazette, second half of 1916, no. 20, November 17, 1916, 5 pp., 6 figs.
A discussion of the efficiency of different types of refrigerator cars and results of tests made on them.

LOW TEMPERATURE COMPRESSION SYSTEM, Harry Sloan. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 5 pp.

A THEORY OF COOLING TOWERS COMPARED WITH RESULTS IN PRACTICE. R. H. Coffey and Geo. A. Horne. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 16 pp., 2 figs., 7 plates, 4 tables.

A FIVE-HUNDRED-TON HIGH SPEED BOOSTER AMMONIA COMPRESSOR. F. L. Fairbanks. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 9 pp., 10 figs.

SAFETY ENGINEERING

REMOVING CAUSES OF CRANE ACCIDENTS, F. H. Elam. The Iron Trade Review, October 26, 1916, 3 pp.

INVESTIGATION OF SAFETY GOGGLES AT UNDERWRITERS' LABORATORIES, Sidney V. James. The Armour Engineer, vol. 9, no. 1, November, 1916, 9 pp., illustrated.

STEAM ENGINEERING

AUTOMATIC BOILER FEED-WATER REGULATORS, F. W. Marquis. Journal of The Ohio Society of Mechanical Electrical and Steam Engineers, vol. 9, no. 1, November 16, 1916, 16 pp., 8 figs.

MODERN SUPERHEATERS, W. H. Maxwell. Cassier's Engineering Monthly, vol. 50, no. 3, September, 1916, 19 pp., 27 figs.

A STUDY OF HEAT TRANSMISSION IN STEAM BOILERS, Victor R. Gage. The Sibley Journal of Engineering, vol. 31, no. 2, November, 1916, 11 pp., 26 figs.

DRAUGHT AND TEMPERATURE REGULATOR FOR MARINE BOILERS, John Ingham. Cassier's Engineering Monthly, vol. 1, no. 5, November, 1916, 6⅓ pp., 4 figs.

POWER AND STEAM TESTS IN CENTRAL FLORIDA, E. W. Kerr. Sugar, vol. 18, no. 9, September, 1916, 2⅓ pp., 4 figs.

UNIFLOW ENGINES AS ROLLING MILL DRIVES, W. Trinks. The Blast Furnace and Steel Plant, December, 1916, 4 pp., 5 figs.

NOTES ON ECONOMICS IN THE USE OF STEAM IN BLEACHING AND FINISHING PLANTS, P. R. Moses. The Isolated Plant, vol. 8, no. 12, December, 1916, 3 pp.

EROSIVE EFFECT OF STEAM ON TURBINE-BLADING MATERIAL, T. J. Keleher. Journal of the American Society of Naval Engineers, vol. 28, no. 4, November, 1916, 5 pp., illustrated.

THE PREVENTION OF FLYWHEEL EXPLOSIONS. Technical Magazine, vol. 7, no. 3, November, 1916, 11 pp., 3 figs.

THERMODYNAMICS

THE CO-EFFICIENTS OF HEAT TRANSMISSION ESTABLISHED BY THE AUSTRIAN ENGINEERS, A. A. Jones. The Heating and Ventilating Magazine, vol. 13, no. 11, November, 1916, 4 pp., 9 figs.

THE PRESENT STATUS OF THE THERMODYNAMIC PROPERTIES OF CARBON DIOXIDE, Fred. G. Keyes and Arthur W. Kenney. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 25 pp., 8 figs.

DETERMINING HEAT TRANSMISSION OF COMPOUND WALLS, WITH TESTS ON INSULATED STEEL CAR SECTIONS, Arthur J. Wood. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 18 pp., 7 figs.

VARIA

THE EQUILIBRIUM OF THE MAGNETIC COMPASS IN AEROPLANES, S. G. Starling. Philosophical Magazine and Journal of Science, vol. 32, no. 191, November, 1916, 16 pp.

ENGINEERING EQUIPMENT OF AN EDUCATIONAL INSTITUTION. Practical Engineer, vol. 20, no. 23, December 1, 1916, 7 pp., 9 figs.
Model underground distribution system employed in connection with power plant of University of Cincinnati.

THE TRAINING OF YOUNG MEN FOR POSITIONS OF RESPONSIBILITY, F. W. Thomas. Official Proceedings of the New York Railroad Club, vol. 26, no. 9, November, 1916, 21 pp.

†THE ENGINEERING SOCIETY—ITS PAST, PRESENT AND FUTURE ACTIVITIES, Ernest McCullough. Journal of the Western Society of Engineers, vol. 21, no. 8, October, 1916, 12 pp.

THE SELLING OF LEAD AND ZINC, H. J. Stander. University of Arizona Bulletin, no. 39, Metallurgical Series no. 3, November 7, 1916, 8½ pp.
Penalties, schedules on concentrates, statistics of zinc smelters.

THE STEEL PIPE CONDUIT AT LOCH RAVEN, MD., Ezra B. Whitman. The Cornell Civil Engineer, vol. 25, no. 1. October, 1916, 5 pp., illustrated.

THE COALING OF SHIPS, Frederick George. Cassier's Engineering Monthly, vol. 50, no. 3, September, 1916, 23 pp., 17 figs.

A MOTOR-OPERATED CLAM SHELL BUCKET. Railway Age Gazette, second half of 1916, no. 21, November 24, 1916, 1 p., illustrated.

THE VALUATION OF LAND, L. P. Jerrard. American Society of Civil Engineers, 35 pp., 3 figs.

THE FINANCIAL ORGANIZATION OF FACTORIES, Edwin L. Orde. Machinery, vol. 9, no. 216. November 16, 1916, 3 pp., 2 figs.

A COMPILATION OF ALL ESSENTIAL PORTIONS OF PENNSYLVANIA LABOR LAWS THAT SHOULD BE KNOWN BY ALL EMPLOYERS, EMPLOYEES, EMPLOYMENT AGENTS AND PROPRIETORS OF INSTITUTIONS AND PUBLIC HALLS THROUGHOUT THIS COMMONWEALTH. Monthly Bulletin, Pennsylvania Department of Labor and Industry, vol. 3, no. 9, September, 1916.

THE SPHERE OF THE SCIENTIFIC AND TECHNICAL PRESS IN RELATION TO TECHNICAL EDUCATION AND RESEARCH, A. P. M. Fleming. The Illuminating Engineer, vol. 9, no. 6, June, 1916, 11 pp.

SCIENTIFIC RESEARCH IN RELATION TO THE INDUSTRIES, Charles P. Steinmetz, Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 8 pp.

THE TIGHTENING-UP PROBLEM. The Practical Engineer, vol. 54, no. 1552, November 23, 1916, 2 pp.

THE LADDER. Iron Tradesman, vol. 76, no. 3, October, 1916, 4 pp., illustrated.

WORKS ORGANIZATION:
Part I. Manufacturing Organization, A. D. C. Parsons; Part II. The Financial Organization of Factories, Edwin L. Orde; Part III. Selling Organization, G. H. Tewrrell. Transactions of the North-East Coast Institution of Engineers and Shipbuilders, vol. 33, no. 1, November, 1916, 46 pp., 10 figs.

CAST-IRON PIPE MANUFACTURE IN THE SOUTH, Y. A. Dyer. The Iron Age, vol. 98, no. 21, November 23, 1916, 4 pp., 7 figs.
Continuous operation and other innovations have put the industry on a new basis of economic production.

ELECTRIC VS. STEAM LOGGING, W. D. Peaslee. Journal of Electricity, vol. 37, no. 21, November 18, 1916, 5 pp., illustrated.

LUMBER STUDIES, BOX TESTS. Monthly Report of the Forest Products Laboratory, October, 1916, 4 pp.

CHARTS

TANGENTIAL FORCE ON BEVEL PINIONS, Piston Displacement. The Horseless Age, November 15, 1916.

A CHART FOR QUICKLY DETERMINING BELT SLIP (Copyright, 1916), W. F. Schaphorst. The Popular Engineer, November, 1916.

CHART FOR DETERMINING SIZES OF ENGINE BEARINGS, Practical Engineer, vol. 20, no. 22, November 15, 1916.

PRODUCTION OF CHART USED BY INTERNATIONAL MACHINE COMPANY TO RECORD PROGRESS IN BUILDING MACHINE TOOLS, Machinery, vol. 9, no. 215, November 9, 1916.

CHART FOR ESTIMATING THE AMOUNT OF COOLING WATER FOR CONDENSER AND THERMAL EFFICIENCY, Haylett O'Neill. Practical Engineer, vol. 20, no. 22, November 15, 1916.

CHART FOR GIVING STROKE AND FLOOR SPACE OF CROSS-COMPOUND PUMPS UNDER DIFFERENT CONDITIONS. Practical Engineer, vol. 20, no. 22, November 15, 1916.

CHART FOR SELECTING RAWHIDE PINIONS, N. G. Near. Machinery, vol. 23, no. 3, November 1916, 2 pp., 2 figs.

FUEL CONSUMPTION AND COST CURVES ON DIESEL ENGINES. Practical Engineer, vol. 20, no. 22, November 15, 1916.

FIXED CHARGES AND LABOR COST CURVES FOR DIESEL ENGINES. Practical Engineer, vol. 20, no. 22, November 15, 1916.

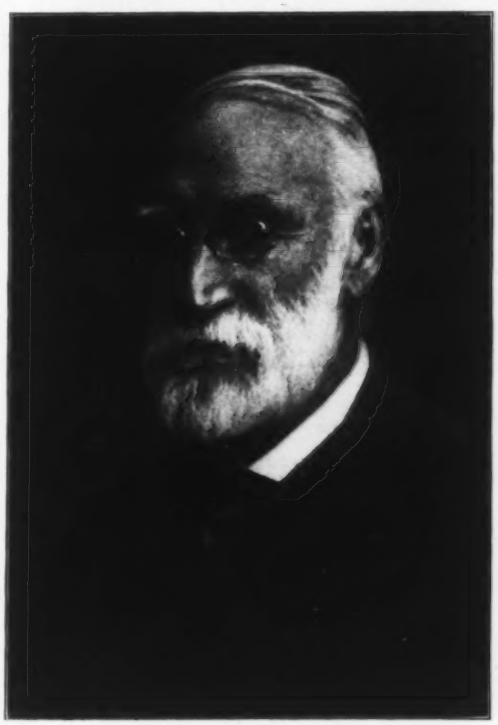
LIBRARY NOTES

From the Library of the United Engineering Society, Engineering Societies Building, New York. Includes Accessions to the Libraries of the Four Founder Societies

Dr. Douglas's Gift

Plans for the expansion of the library of The United Engineering Society are being made which will render the library unique, not only in the collection of technical books and periodicals, but also in the service it will be prepared to render to the members of any branch of the engineering profession.

These plans have been made possible by the initial gift of $100,000 from Dr. James Douglas, as the beginning of an endowment fund which it is hoped will reach $1,000,000. One



DR. JAMES DOUGLAS

of the initial steps in these plans is to place on the library shelves every engineering periodical published in the world, no matter in what language, and the same broad policy will be followed in the acquisition of reference books.

Dr. Douglas's gift has suggested large possibilities, and with the consolidation of the library of the American Society of Civil Engineers with that of the three original Founder Societies, the ultimate should be a library of universal service to the engineering profession.

Am. Soc. M. E. Accessions

THE JOHN BOGART LETTERS. 1776-1782. *New Brunswick, N. J., 1914.* Gift of President of Rutgers College.

CHICAGO, BOARD OF SUPERVISING ENGINEERS. CHICAGO TRACTION, Annual Report 7th, 1914. *Chicago, 1916.* Gift of Bion J. Arnold.

HEAVY TIMBER MILL CONSTRUCTION BUILDINGS, C. E. Paul. Ed. 2. *Chicago, 1916.* Gift of National Lumber Manufacturers' Association.

HOW TO BUILD UP FURNACE EFFICIENCY. A hand book of fuel economy. Ed. 7, by Jos. W. Hays. n. p. 1914. Gift of G. L. Simonds & Co.

HOW YOU MAY SAVE MONEY IN OPERATING YOUR STEAM BOILERS. Ed. 3. Revised by E. L. Webster. Gift of A.S.M.E.

INSTITUTION OF CIVIL ENGINEERS. Minutes of Proceedings. Vol. CXCIX. *London, 1915.*

MECHANICAL EQUIPMENT OF BUILDINGS, Louis Allen Harding and Arthur Cutts Willard. *New York, John Wiley & Sons, 1916.* Gift of Louis Allen Harding.

MESSERSCHMITT PROCESS FOR THE REPRODUCTION OF HYDROGEN, H. L. Barnitz. Reprinted from Metallurgical and Chemical Engineering, vol. 15, no. 8, 1916. Gift of author.

MOSQUITO CONTROL IN PANAMA. The Eradication of Malaria and Yellow Fever in Cuba and Panama, J. A. Le Prince and A. J. Orenstein. *New York, G. P. Putnam's Sons, 1916.* Price $2.50. Gift of publishers.

The joint authors were associated with General Gorgas in Cuba and Panama as chief and assistant chief sanitary inspectors. This book gives a detailed account of the conditions found, the measures adopted for mosquito extermination, and the results obtained. No engineer doing or planning work in the tropics should miss reading this work. The extermination of the mosquito made possible the completion of this gigantic engineering feat. W. P. C.

NEW YORK CITY DEPARTMENT OF BRIDGES. Report, 1914-1915. *New York, 1915.* Gift of A.S.M.E.

NEW YORK STATE CONSERVATION COMMISSION. Annual Report 5th, 1915. *Albany, 1916.* Gift of Conservation Commission.

PENNSYLVANIA WATER SUPPLY COMMISSION. Annual Report, 1915. *Harrisburg, 1916.* Gift of A.S.M.E.

QUEENSLAND HARBOURS AND RIVERS. Report from the Engineer for year ended June 30, 1916. Gift of Queensland Engineer for Harbours and Rivers.

RELATIF A UNE NOUVELLE DETERMINATION DES VALEURS DES PUISSANCES DANS LES ESSAIS D'HELICES. Fascicule. (A encarter dans l'ouvrage Nouvelles Recherches sur la Resistance de l'air et l'Aviation. 1914). Gift of G. Eiffel.

TRACTIVE RESISTANCES TO A MOTOR DELIVERY WAGON ON DIFFERENT ROADS AND AT DIFFERENT SPEEDS, A. E. Kennelly and O. R. Schurig. Bulletin no. 10, Massachusetts Institute of Technology, Electrical Engineering Dept.

UNITED STATES GOVERNMENT PUBLICATIONS PERTAINING TO PULP AND PAPER, H. E. Surface. Reprinted from Paper, October 4, 1916. Gift of author.

WASHINGTON ACADEMY OF SCIENCES. McGee Memorial meeting, December 5, 1913. *Baltimore, 1916.* Gift of Washington Academy of Sciences.

WORM GEARING, Hugh Kerr Thomas. Second edition. *New York, McGraw-Hill Book Company, 1916.* Gift of author.

An important use for worm gearing is rapidly developing in connection with the reduction of steam turbines for marine propulsion. Other uses are for automobile gears and gears for driving line shafting from electric motors. The mere fact that a second edition is demanded so soon as in three years shows the great interest in this branch of applied mechanics. The author has added to this edition appendices devoted to efficiency, reversibility, and an alternative method of calculating stresses. W. P. C.

TRADE CATALOGUES

AMERICAN BLOWER CO. *Detroit, Mich.* Bulletin No. 13. "A. B. C." Disc Ventilating Fans. *June 1916.*

AMERICAN ROLLING MILL CO. *Middletown, Ohio.*

ARMCO TRIANGLE. *November 1916.*

CHICAGO PNEUMATIC TOOL CO. Chicago, Ill. Bulletin no. 129. Hose, hose couplings and hose clamp tools. *November 1916.*
——— 130. Lubrication of pneumatic tools. *November 1, 1916.*
——— 266. "Rockford" railway motor cars.
——— E-45. Duntley Portable electric hoists. *November 1, 1916.*

FLANNERY BOLT CO., *Pittsburgh, Pa.* Staybolts. *November 1916.*

GOLDSCHMIDT THERMIT CO. *New York, N. Y.* Reactions. vol. 9, no. 3.

GURNEY HEATER MANUFACTURING CO. *Boston, Mass.*
Lenox boilers, steam and hot water.
Essex boilers.
Sectional boilers, 900 series; Bright Idea series, 1915 type.
Water supply boilers.
400 series boilers (round), steam-water.
Down-draft boilers (for soft coal).
Gas water heater.
Radiators.

HUNT, RODNEY MACHINE CO. *Orange, Mass.* Catalogue no. 30, Section WCA. Water controlling apparatus.

LINK BELT CO. *Philadelphia, Pa.* Handling coal in the Victor Power plant. (Book no. 296.)
Handling coal and ashes in the power house of William H. Grundy Co. with Link-Belt machinery. (Book no. 288.)

NEWTON MACHINE TOOL WORKS. *Philadelphia, Pa.* Catalogue no. 51. Cold saw cutting off machines.

STEPHENS-ADAMSON MANUFACTURING CO. *Aurora, Ill.* Labor Saver. *November 1916.*

SUPERNO CO., INC. *New York, N. Y.* Superno patented steel superheaters.

TEXAS CO. *New York, N. Y.* Lubrication. *November 1916.*

UNDER-FEED STOKER CO. OF AMERICA. *Chicago, Ill.* Publicity Magazine. *November 1916.*

VALLEY IRON WORKS CO. *Appleton, Wis.* The Beater. *November-December 1916.*

WALWORTH MFG. CO. *Boston, Mass.* Walworth Log. *November 1916.*

U. E. S. Accessions

ACCIDENTS AT METALLURGICAL WORKS IN THE UNITED STATES DURING 1915. U. S. Bureau of Mines. Technical paper 164. *Washington, 1916.*

AMERICAN SOCIETY FOR TESTING MATERIALS STANDARDS. 1916. *Philadelphia, 1916.*

ASSAY OF TIN AND ANTIMONY, L. Parry. Ed. 2. *London, n. d.*

BALTIMORE AND OHIO RAILROAD. Reprint of articles. *July 1916.*

BIBLIOGRAPHY—SPONTANEOUS COMBUSTION AND WEATHERING OF COAL. Gift of Edwin B. Ricketts.

CAGNEGIE STEEL COMPANY. Pocket Companion for engineers, architects, and builders, containing useful information and tables appertaining to the use of steel. Ed. 19. *Pittsburgh, 1917.* Gift of Carnegie Steel Company.

CASE FOR THE RAILROADS, Howard Elliott. From New York Times, Magazine Section, September 10, 1916.

CATALOGUE OF THE HOPKINS RAILWAY LIBRARY, F. J. Teggart. *Palo Alto, Cal., 1895.*

CENTENNIAL CELEBRATION OF THE UNITED STATES COAST AND GEODETIC SURVEY, 1916. *Washington, 1916.*

CHARLOTTE, N. C., CODE OF THE CITY. Charter and Ordinances. July 1914. *Charlotte, 1915.* Gift of the City Clerk.

COLD STORAGE AND ICE ASSOCIATION. Proceedings, vol. XIII. *London, 1916.*

COLORADO SCIENTIFIC SOCIETY. Constitution and By-Laws. January 1, 1916.

COLUMBIA (S. C.) BUILDING DEPARTMENT. Building Code, 1916. *Columbia, 1916.* Gift of Building Department.

CONGRESS AND THE SHIPPERS, G. A. Post.

ELECTRIC POWER CLUB. Executive Staff, Member Companies, Committees, Constitution and By-Laws, etc. August 1, 1916. Gift of Club.

ELENCO DEI FABBRICANTI IN ITALIA DI MATERIALE E MACCHINARIO ELETTRICO. October 1916. *Milano, 1916.* Gift of Associazione Elettrotecnica Italiana.

FEDERAL VALUATION OF THE RAILROADS IN THE UNITED STATES. List of Valuation Committees of the railroad companies and principal officers and employees of the Interstate Commerce Commission engaged in appraisal work. October 1916. *Philadelphia, 1916.* Gift of Clemens Herschel.

FLORIDA GEOLOGICAL SURVEY. Annual Report 8th. *Tallahassee, 1916.*

A FOREST CENSUS OF ALABAMA. Reprinted from the Proceedings of the Society of American Foresters, vol. XI, no. 2. *University, Ala., 1916.*

GALVESTON (TEXAS) BUILDING DEPARTMENT. Building Code, 1914. Gift of Galveston Building Department.

GEOLOGY OF THE NANAIMO MAP AREA. Canada Department of Mines, Memoir 51. *Ottawa, 1914.*

HANDBUCH DER REGIONALEN GEOLOGIE. Edited by G. Steinmann and O. Wilckens. Pts. 1-18. *Heidelberg, 1910-1915.*

HILL, JOHN A. Some of the writings of. Gift of Power.

HORLOGERIA THÉORIQUE, H. Grossmann. 2 vols. *Paris, 1911, 1912.*

LA HOUILLE BLANCHE. vols. 1-11, 1902-1912. *Paris, 1902-1911.*

INKS, THEIR COMPOSITION AND MANUFACTURE, C. A. Mitchell and T. C. Hepworth. Ed. 2. *London, 1916.*

INSTITUTION OF CIVIL ENGINEERS OF IRELAND. Transactions, vol. XLII. *Dublin, 1916.*

INSTITUTION OF MECHANICAL ENGINEERS. Alloys Research Committee. Report 1st-8th and Appendix. *London, 1891-1907.* Gift of Bradley Stoughton.

INSTITUTION OF NAVAL ARCHITECTS. Transactions, vol. LVIII. 1916.

INTERNATIONAL ENGINEERING CONGRESS. 1915. Index volume. *San Francisco, 1915.*

INVESTIGATION OF THE COALS OF CANADA. (Extra volume.) *Ottawa, 1915.*

IOWA GEOLOGICAL SURVEY. Annual Report. Vol. XXV. 1914. *Des Moines, 1916.*

IRON AND STEEL INSTITUTE. Carnegie Scholarship Memoirs, vol. VII. *London, 1916.*

KANSAS GAS, WATER, ELECTRIC LIGHT AND STREET RAILWAY ASSOCIATION. Proceedings of 18th annual meeting, October 21-23, 1915. Gift of Association.

KRAUSE ABSORBENT FILTER. Pure and safe feed water from oily condensate of all kinds guaranteed by using. Gift of A. E. Krause.

LATE PLEISTOCENE OSCILLATIONS OF SEA LEVEL IN THE OTTAWA VALLEY. Canada Department of Mines. Museum Bulletin no. 24. *Ottawa, 1916.*

LAW OF AUTOMOBILES, X. P. Huddy. Ed. 4. *Albany, 1916.*

LIGHT OIL FIELDS OF WYOMING. Wyoming State Geologist. Bulletin no. 12. *Cheyenne, 1916.*

LIST OF INSPECTED ELECTRICAL APPLIANCES. October 1916, Supplement to April 1916. Gift of Underwriters' Laboratories.

MADISON (WIS.) INDUSTRIAL COMMISSION. Building Code. 1915.
——— Fire Protection in Schools. 1914.
——— General Orders on Safety Building Construction. 1914.
——— Proposed Orders on Fire Protection in Existing Buildings, Including Also Sanitation in Existing Tenements and Theaters. 1915. Gift of Commission.

MECHANICS OF TELEPHONE RECEIVER DIAPHRAGMS, AS DERIVED FROM THEIR MOTIONAL IMPEDANCE CIRCLES, A. E. Kennelly and H. A. Affel. Massachusetts Institute of Technology. Electrical Engineering Department, Buletin no. 8, November 1915. Reprinted from the American Academy of Arts and Sciences. Proc., November 1915. Gift of Massachusetts Institute of Technology, Electrical Engineering Dept.

MELTING ALUMINUM CHIPS. U. S. Bureau of Mines. Bulletin no. 108. *Washington, 1916.*

MINES HANDBOOK AND ENLARGEMENT OF THE COPPER HANDBOOK, W. H. Weed. Vol. XII. *New York, 1916.*

NATIONAL ENGINEER. Vols. 1, 2; vol. 5, nos. 1-4, 7-8, 10-12; vol. 6; vol. 8, nos. 1-10. *Chicago, 1897, 1898, 1901, 1902, 1904.*

NEEDS AND THE OPPORTUNITY OF THE RAILROAD SITUATION, W. D. Hines. Address delivered at the 5th annual convention of the Investment Bankers' Association, October 4, 1916.

NEW JERSEY GEOLOGIC MAP, J. V. Lewis and H. B. Kümmel. 1910-1912.

NEW YORK CITY'S ADMINISTRATIVE PROGRESS, 1914-1916. *New York, 1916.* Gift of New York City Municipal Reference Library.

NEW YORK ELECTRIC RAILWAY ASSOCIATION. Annual Report, 31st-33d. v. p. 1913-1915. Gift of Association.

NEW YORK TIMES INDEX. Vol. IV. July-September 1916. *New York, 1916.*

NEW YORK, NEW HAVEN AND HARTFORD RAILROAD COMPANY. Statement by Howard Elliott, October 16, 1916.

THE NITRATION OF TOLUENE. U. S. Bureau of Mines. Technical Paper 146. *Washington, 1916.*

NORFOLK, VA. Tentative report, proposed building ordinances, March 25, 1915. Gift of City Clerk.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS. Transactions, vol. 32. *Newcastle-upon-Tyne, 1916.*

OFFICIAL AMERICAN TEXTILE DIRECTORY, 1916. *New York, 1916.*

OHIO PUBLIC UTILITIES COMMISSION. Annual Report. 1914, 1915.
——— Laws of Ohio relating to Public Utilities. 1916.
——— Rules of practice before the Commission. 1916. Gift of Public Utilities Commission.

OIL SHALES IN IMPENDILE COUNTY, NATAL. Report on. *Pretoria, 1916.*

OXY-ACETYLENE WELDING AND CUTTING, H. P. Manly. *Chicago, 1916.*

PASSAIC, N. J. Ordinance Concerning Streets and Public Buildings of the City. 1888. Gift of City Clerk.

PENNSYLVANIA SECRETARY OF INTERNAL AFFAIRS. Pt. I, Land-Office-Boundary Lines; Pt. II, Assessments-Taxes. *Harrisburg, 1916.*

PLEISTOCENE AND RECENT DEPOSITS OF THE ISLAND OF MONTREAL. Canada Bureau of Mines Department, Memoir 73. *Ottawa, 1915.*

PROBLEM OF THE RAILROADS IS YOUR PROBLEM, L. B. Franklin. Reprinted from the address of the President of the Investment Bankers' Association, October 2, 1916.

PRODUCTION OF IRON AND STEEL IN CANADA DURING 1915. *Ottawa, 1916.*

RAILROAD CREDIT AND REGULATION, A. J. County. Pennsylvania Railroad System Information, November 4, 1916.

REGELN FÜR LEISTUNGSVERSUCHE AN VENTILATOREN UND KOMPRESSOREN. Aufgestellt vom Verein deutscher Ingenieure und dem Verein deutscher Maschinenbau Anstalten im Jahre 1912. Gift of Leon Goldmerstein.

REGISTER OF NATIONAL BIBLIOGRAPHY, W. P. Courtney. Vols. 1-3. *London, 1905, 1912.*

REVISION OF PRIMARY LEVELS AND LIST OF BENCH MARKS IN NORTHERN NEW JERSEY. Bulletin no. 17, N. J. Geologic Series. *Trenton, 1916.*

ROAD MATERIAL SURVEYS IN 1914. Canada Department of Mines, Memoir 85. *Ottawa, 1916.*

SMULL'S LEGISLATIVE HANDBOOK AND MANUAL OF THE STATE OF PENNSYLVANIA. 1916. *Harrisburg, 1916.*

SOCIETY OF RAILWAY FINANCIAL OFFICERS. An Address by the Hon. Frank A. Vanderlip, October 20, 1916.

TITLES TO MINES IN THE UNITED STATES, W. A. Harris. *London, 1877.* Gift of Bradley Stoughton.

TRENT VALLEY OUTLET OF LAKE ALGONQUIN AND THE DEFORMATION OF THE ALGONQUIN WATER PLANE IN LAKE SIMCOE DISTRICT, ONTARIO. Canada Department of Mines, Museum Bulletin no. 23. *Ottawa, 1916.*

UNION OF SOUTH AFRICA. Department of Mines and Industries. Annual Report of the Government Mining Engineer, 1915. *Pretoria, 1916.*

USE OF MUD-LADEN FLUID IN OIL AND GAS WELLS. U. S. Bureau of Mines. Bulletin 134. *Washington, 1916.*

U. S. PATENT OFFICE. Manual of classification of subjects of invention. Revised to January 1, 1916. *Washington, 1916.*

VALUATION OF THE NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS. Report of the Committee. Scope of the Committee's jurisdiction. November, 1916. Gift of Clemens Herschel.

WESTERN AUSTRALIA. Geological Survey. General Index to Reports 1870-1910. Bulletin no. 60.

WIDERSTANDSMOMENTE. TRÄGHEITSMOMENTE UND GEWICHTE VON BLECHTRÄGERN, R. Böhm and E. John. Ed. 2. Gift of Catalogue Equipment and Supply Company.
——— Catalogue Studies. vols. 1, 4, 6, 7, 10, 12, 15, 23, 24, 27, 28, 34, 37-40, 42, 43, 48 and index.
——— Blue Print Book. 56 prints.

EXCHANGE

SOCIEDAD NACIONAL DE MINERIA. Boletin. Ano 1, nos. 4-5, 7-24, Ano. 2, nos. 25-29, 31-43, 45-48; Ano. 3, nos. 49-54, 56-66. *Santiago, 1884-1886.*

GIFT OF CATALOGUE EQUIPMENT AND SUPPLY COMPANY

99 UNITED STATES TOPOGRAPHICAL MAPS OF NEW YORK, NEW JERSEY

GIFT OF F. K. GILLESPIE

99 UNITED STATES TOPOGRAPHIC MAPS OF NEW YORK, NEW JERSEY AND PENNSYLVANIA.

GIFT OF CLEMENS HERSCHEL

COLLECTION OF REPORTS OF PRESIDENTS' CONFERENCE COMMITTEE ON FEDERAL VALUATION OF THE RAILROADS IN THE UNITED STATES.

TRADE CATALOGUES

AMERICAN BLOWER COMPANY. *Detroit, Mich.* Sirocco Service.

AMERICAN GRONDAL CO. *New York, N. Y.* Grondal briquetting. Concentrates made by Grondal separators. Magnetic separators.

BACHARACH INDUSTRIAL INSTRUMENT CO. *Pittsburgh, Pa.* Catalog B. Hudro volume and pressure recorders.

BUFFALO FOUNDRY AND MACHINE COMPANY. *Buffalo, N. Y.* Chemical Apparatus. "Buflokast" and "Buflovak."

CROCKER NATIONAL FIRE PREVENTION ENGINEERING COMPANY. *New York, N. Y.* Prevention of Fire.

IVANHOE REGENT WORKS OF THE GENERAL ELECTRIC COMPANY. *Cleveland, O.* The Hunchman. *September 1916.*

KOEHRING MACHINE COMPANY. *Milwaukee, Wis.* Koehring Mixer. *August-September 1916.*

NITROGEN PRODUCTS COMPANY. *Providence, R. I.* Fixation of Atmospheric Nitrogen. *1916.*

SUPPLEE-BIDDLE HARDWARE CO. *Philadelphia, Pa.* Monel metal. *November, 1916.*

TEXAS COMPANY. *New York, N. Y.* Lubrication. *October 1916.*

UNDER-FEED STOKER COMPANY OF AMERICA. *Chicago, Ill.* Publicity Magazine. *September-October 1916.*

UNITED SHOE MACHINERY ATHLETIC ASSOCIATION. *Beverly, Mass.* The Three Partners. *September 1916.*

WALLACE SUPPLY CO. *New York, N. Y.* Hand power bending tools.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY. *East Pittsburgh, Pa.* Catalogue 3-B. Westinghouse Instruments. *July 1916.*

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. *East Pittsburgh, Pa.* Circular no. 1516-A. Baldwin-Westinghouse electric locomotives for interurban freight haulage. *October, 1916.*
——— Circular no. 1576. Joe and the General Manager at the A. E. R. A. Convention. *October, 1916.*
——— D. L. 3952. Westinghouse direct-current railway equipments, 1200-1500 volts.
——— Leaflet 3561-A. OISC transformers-radiator tank type.
——— Leaflet 3865. Westinghouse HL unit switch control.
——— Leaflet 3905. Liquid rheostatic control for large A. C. wound rotor motors.
——— Leaflet 3926. Freight haulage with Baldwin-Westinghouse electric locomotives.
——— Leaflet 3946. Baldwin-Westinghouse electric locomotives.
——— Leaflet 3953. Westinghouse HLD control.
——— Special Publication 1577. Standard railway equipments.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by January 16 in order to appear in the February issue

CHANGES OF POSITION

MANNING E. RUPP, for a number of years with the Panama Canal, has accepted a position as superintendent with the Curtis Pneumatic Machinery Company, St. Louis, Mo.

H. O. C. ISENBERG has been made chief engineer of the Scripps-Booth Company of Detroit. He was formerly associated with the Ferro Machinery and Foundry Company of Cleveland, O.

KENNETH A. MESEROLE, formerly in the engineering department of the American Beet Sugar Company, Oxnard, Cal., has become associated with the Stearns-Roger Manufacturing Company, Denver, Colo.

W. M. IMBRIE, JR. recently resigned as superintendent of the Chattanooga Chemical Company to become engineer in charge of construction for the Atlantic Pulp and Paper Company, Savannah, Ga.